SCIENCE AND THE PUBLIC MIND

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SCIENCE

AND

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BY

BENJAMIN C. GRUENBERG

WITH A FOREWORD

BY

JOHN C. MERRIAM

President of the Carnegie Institution of Washington

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FOREWORD

REFERENCE to the present period as the age of science may suggest any one of a variety of interpretations, according to the question under discussion. It may be interpreted to mean that this is a time when great material wealth or plenty is arising out of the products of science; or it may mean that this is an age in which science is making its most important contribution by opening broader visions of the world with everything in it, and furnishing better, more accurate, and more dependable modes of thought. To those who see the scientific age from the second position, the equipment made available to our minds and the consequent effect upon life are more significant than the wealth produced.

Whatever the point of view taken regarding the essential characteristics of a scientific age, we may not avoid recognizing the dependence of science upon education for development and for continuity of the values obtained. But there may be wide difference between education in its relation to science considered merely as a producer of material wealth, and education in relation to science recognized as an influence upon our modes of thought and manner of life.

Considered as valuable primarily because of its production of wealth and economic opportunity, science and its contribution of plenty might advance from stage to stage under the guidance or control of a relatively small percentage of the people. Education would be essential as the means for transmitting information and for stimulating new ideas leading to increased and widened production. It would also be desirable that the people as a whole become acquainted with the value of science, in order to maintain adequate opportunity for advance.

If, on the other hand, the significance of scientific work as developing wider vision, bettered modes of thought, and improved attitudes of mind is considered, then education becomes of surpassing importance as the means by which science can be interpreted to the individual and to the masses, and the leaven of its influence be made to permeate the thought and life of the entire population. With this conception of values in science it would not be adequate to have acquaintance with the point of view or the logic of science limited to any small group of leaders in thought. It would be necessary to make provision by which these ideas could become the common property of all individuals. Only through such an extension of the influence of science could we expect to derive the full values which might properly come to the people as a whole.

In this connection it is important to note that whatever the ultimate fate of government by the people, the highest success in a system of that type can be attained only by development of a citizenry thinking continuously and effectively according to a pattern which is fundamental in science, namely, one which involves wide and clear vision, recognition of need for continuous inquiry upon great questions, and the settlement of problems on the basis of facts and logic.

If the argument presented is correct, the relation of education to science will be especially important when one considers the values of what we call science to be found in its influence as a mode of thought or manner of life. Under these conditions it would be necessary to recognize that, while every phase of educational effort is important in relation to science, emphasis should be placed upon avenues through which at least the rudiments of scientific education can become available to everyone. At the same time it is necessary to stress those special means by which such education can be continued into or through the period of major activities in mature life. Tremendous as are the values of education in youth, we know that much of what is done at that time is equivalent to sowing seed which we hope to see develop at a later period if favorable

conditions are encountered. In attempting to realize the full values of science it is essential that, in addition to education of the youth, we care for continuing growth by types of adult education that develop at the time when the learning process is adjusted to the most effective relations of life.

Whether they concern science or other subjects, the processes by which this continuing growth of the adult develops will vary from time to time and will, in all probability, never lend themselves wholly to organization or classification. In science they will include every phase of literature, especially current publications represented by the public press. Much will be accomplished by motion pictures, museums, and the radio, and by discussion of great discoveries, either in pure science or in the operations of well-known industries. Formally organized study groups will also have their part. Critically important is the fact that continuing exercise and growth of the inquiring mind are among the greatest possible safeguards in a government resting upon the ideals and judgment of the people.

The following study on the place of science in relation to adult education prepared by Dr. Gruenberg makes clear the importance of science to the public, and presents an extremely interesting and valuable picture of the types of activities now in existence, or which may be created.

It can, I believe, be predicted that, along with increasing values in a small group of fundamental human interests, such as art and civic righteousness, we may look forward to the growing importance of science presented through adult education as a manner or mode of thought essential in the kind of civilization and the type of government which we desire to see realized.

JOHN C. MERRIAM
President, Carnegie Institution of Washington

WASHINGTON, D. C.,
April, 1935.

PREFACE

THE justification for inflicting another book upon the public, and for taking the time of many busy people in preparing it, must lie in certain broad considerations. If society is to maintain its health and sanity, the public at large must either be trained to accept the guidance and direction of a special class, whether of priests or of politicians, whether of economic masters or of soldiers, or else it must be trained to take part in the knowledge, the culture, the thought, the concepts upon which its civilization rests. This alternative suggests broadly the contrast—and the conflict—between autocracy and democracy.

That this is so was more or less clearly realized by the founders who committed this nation to a democratic course, and who looked to education as a means of training the governing class—that is, the voting citizens. These educational efforts bore fruit on an expanding scale in school organizations that came at last to devote themselves with probably increasing effectiveness to the diffusion of the wisdoms accepted of old.

The school, however, can no longer keep up with the civilization it is designed to preserve. Especially is the school as conventionally conceived and conducted unable longer to keep up with science. For, on the one hand, science has modified and must continue to modify our culture, so that this is no longer compatible with certain traditional attitudes and assumptions as to educational purposes and methods, which determine a substantial portion of both the teachers' training and the teachers' teaching—still almost universally a process of transmitting crystallized concepts. And, on the other hand, science is vitally related to the continuance in a tolerable degree of physical and emotional comfort of the human beings who constitute our civilization, so that adjustments in outlooks

and practices must be made in directions and at rates which the school cannot possibly anticipate.

It is from the field of science that the adult population must draw increasingly the guidance essential for the perpetuation of democratic ideals and conditions. And it is believed that in this field adult education is seriously lacking.

The book represents the interaction of many minds called upon to think aloud on various aspects of the relationships between that vague entity called "science" and that perhaps even more vague something known as "the public." The study was undertaken at the invitation of the American Association for Adult Education to look into the "place of science in adult education" and was carried on under a grant from the Carnegie Corporation of New York. To these agencies is due the opportunity to organize whatever may here be of value to the public; and to Mr. Morse A. Cartwright and Mr. Frederick P. Keppel are due the writer's thanks for much practical assistance, wise counsel, and encouragement in the course of the work.

The purpose of the study, being limited as it was in the time allowed, was to find the general conditions, trends, outstanding needs. There was no intent to make a complete survey or an exhaustive analysis. The basic material consists therefore essentially of an assemblage of samples derived from various sources; and there is an attempt to interpret the findings.

There are samples of facts: What is actually being done? On how large a scale? To what effect? There are samples of opinions: What do various classes of people (whose judgment is presumably both informed and disinterested) consider to be the meaning of the facts, the practical needs they indicate, the most promising procedures? These samples are assumed to be sufficiently representative to warrant certain generalizations and conclusions.

There have been interviews or conferences with some two hundred educators, scientists, publicists, and a great deal of correspondence with these and with others, as well as much correspondence with administrators of educational and other

institutions. These men and women have been most generous of their time and effort and altogether sympathetic and cooperative. It is impossible to enumerate all who have helped; but this work could not have been carried through without this assistance, which is gratefully acknowledged. Conferences had been arranged in Baltimore, Boston, Chicago, and Cleveland, as well as in New York; and there was a more formal conference of thirty educators, scientists, and publicists in New York, leading to the formation of a committee to consider useful lines of further action, under the chairmanship of President John C. Merriam of the Carnegie Institution of Washington. The generalizations and recommendations presented in the concluding chapter were, in their essentials, approved by the members of this committee and by most of the participants in the conference.

Correspondents and conferees are frequently cited without specific reference to sources. It is to be understood, however, that the analyses and interpretations are to a large degree and of necessity personal, although supported at various points by documents, statistics, and other people's opinions. On the other hand, I have searched diligently for the negative instances and the contrary opinions; and I have tried to reconcile seeming discrepancies by relating the facts and opinions to the needs and currents in contemporary life.

B. C. G.

NEW YORK, N. Y.,
April, 1935.

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INTRODUCTION

THE EXPANSION OF SCIENCE IN EDUCATION AND IN LIFE

IT is a commonplace that we are living in an age that has been revolutionized by science, which is constantly modifying the conditions of life still further. Whatever else may be said regarding the nature of "adult education" and regarding its desirability, science has imposed new demands upon us, for the workings of science in modern living are such that men and women are constantly called upon to readjust their thinking and their practices.

In the seventy-five years that have elapsed since the publication of Darwin's *Origin of Species*, science has completely changed its place in our common thought. From being a major mystery in the custody of a few curious men who had somehow mastered certain of nature's secrets, and then a collection of several "subjects" taught more or less thoroughly to young people in the schools, science has come to be a dynamic process of scrutiny and research that attacks and transforms every phase of thought and practice. The men and women who make up the active adults of our population must attend to science, in one or another of its many aspects, whether they wish to or not. And they do.

DANGER OF LITTLE KNOWLEDGE

The popularization of science has tended to become something of a condescension. Many of those who make it their business to tell the world what the scientists are doing have been disposed to emphasize the spectacular and exciting. Science has produced startling results by bringing about action through space. Not

only can you hear Byrd's voice in the comfort of your home while he is buried in snow thousands of miles away; you can have the front door of your exposition opened by a beam of light from the star Arcturus, which is much farther away. Science has enabled us to see through the deceptions and illusions which unscrupulous mountebanks in the past imposed upon an ignorant and gullible public. It has exposed spiritual mediums, and defective armor, and forged signatures. And it has in turn enabled us to perform miracles undreamt of in the past. It not only supplies a circus of amazing entertainment, but it overcomes baffling difficulties of great moment.

Thus it has been possible to "sell" science to the multitudes; and such popularization has the effect of disposing the public favorably toward science, of arousing admiration for the scientist. All this, however, has one serious drawback. By familiarizing the public with the terms and symbols that suggest the marvelous, we may condition this public to further exploitation of its credulity and pave the way for quacks and frauds who can reinforce their blandishments with the magic words supplied by "science." The mere selling of science may thus become a disservice. The mere familiarizing of the public with the new words may do more harm than good.

If it is true that a little knowledge is a dangerous thing, we have an important decision to make. Either we must withhold from the public all science, or we must carry the knowledge and understanding beyond the threshhold of a social menace.

CHANNELS OF DIFFUSION

The diffusion of science goes forward not alone through "education" of the schools and through "popularization" of the lecture, the newspaper, the broadcast, and so on. There is a third method which is unavoidable since it is closely connected with commercial exploitation, the very process whereby the science applied in the various technologies comes into our daily lives.

A large part of this diffusion is in the form of manipulating new devices, enjoying new conveniences or mere "gadgets" that have nothing to commend them but novelty. We all thus learn to push buttons or pull levers, turn knobs and watch indicators, to rearrange our diets or our wardrobes, to light cigarettes or squeeze lemons in new ways. Indeed, the printed, and sometimes illustrated, directions for the use and care of various machines and devices, and the advertising for promoting commercial products, are frequently excellent means of scientific education. In taking over the new inventions and devices, new rules for keeping well or for carrying on the day's work, we are by so much assimilating "science," since these novelties commend themselves not only for such inherent merit as they may have, or for such addition as they may make to our comfort or well-being, but also for the virtue that is supposed to emanate from whatever passes as "scientific."

CONCRETE CHANGES

The commercial and administrative and technical impositions of new concepts and new practices do not, of course, serve the same social and spiritual purposes that we have in mind when we consider an educational plan. But they do bring about changes in attitudes as well as changes in ideas and conduct that are all outcomes of the impact of science upon modern life.

So far as concerns the population at large, these changes have the effect of

1 Facilitating action in a thousand details that become more or less unconscious as they become assimilated and automatic;

2 Enlarging the total of available leisure as well as the scope for its enjoyment;

3 Increasing the sense of power to accomplish difficult tasks and to solve difficult problems—to the point, in fact, of cultivating a new and uncritical credulity; and

4 Expanding our horizons, magnifying our vision as to the dignity and potentialities of mankind—to the point of making

the mass of people suffer a sense of inferiority to a serious degree, for the contrast between the great possibilities glamorously displayed and the mean restrictions under which the masses *actually live* is unbearably depressing, and a source of constant self-deprecation as well as of resentment.

These changes involve, as a matter of course, far-reaching alterations in our social, economic, and political *relationships*. These relationships, however, while bringing gains and losses unevenly to the various individuals and groups, are not in themselves of primary concern to the "scientists" as such, except as the measurable gains are aggregated for promoting the public's appreciation of science. Indeed, the efforts of the special students of economic, social, and political problems to become scientific take the form generally of applying the objective methods of scientific research to the *facts* in almost complete disregard of the human values and meanings (again excepting an emphasis upon measurable gains).

CURIOSITIES

However far our technicians may go in making our machinery automatic and fool-proof, there will still remain, for some people at least, a curiosity as to how things work, as to the nature of the world; and some of these are willing to make serious efforts for the mental satisfactions which they get as a result. Some will be curious about the depths of the earth and sea; some about the multitudes of plants or animals; about the achievements of science that have become embodied in tricky devices; about the phenomena from which the scientists start their investigations, and which they seek eventually to control, and which cannot be hidden in sealed cabinets. People want to know, not only for the power which knowledge may yield, but for the satisfaction that knowing yields, or the attaining of knowledge as an experience.

The great variety of activities that can be carried on with the materials of nature or of the laboratory or of the museum

collection, the great variety of satisfactions that can come from preoccupation with such activities, leave room for many kinds of "education in science."

It thus becomes urgent for people in general to get a clearer understanding than now obtains as to just what this "science" is, as to just how it produces its results, as to just how it affects our ways of living, as to just what we can do with it, or about it.

PART I

THE PLACE OF SCIENCE IN MODERN LIFE

I

SCIENCE AND THE LAYMAN

AMONG the educators, there is increasing and at present substantial agreement that science should occupy a more prominent place both in the systematic education of young people and undergraduates and in the education of adults. Superintendent Harold G. Campbell of New York City says that everybody needs a better understanding of the material environment, and "this applies to much more than knowing the connection between a button and what happens after you push it." In one of his characteristic newspaper sermonettes, President Glenn Frank of the University of Wisconsin, under the title "Salesmen of Knowledge," writes,

> The knowledge of mankind is advanced by the investigator, but the investigator is not always the best interpreter of his discoveries. . . . The interpreter stands between the layman, whose knowledge of all things is indefinite, and the investigator, whose knowledge of one thing is authoritative. The investigator advances knowledge. The interpreter advances progress. History affords abundant evidence that civilization has advanced in direct ratio to the efficiency with which the thought of the thinkers has been translated into the language of the workers. Democracy of politics depends upon democracy of thought. "When the interval between intellectual classes and the practical classes is too great," says Buckle, "the former will possess no influence, the latter will reap no benefit." A dozen fields of thought are today congested with knowledge that the physical and social sciences have unearthed, and the whole tone and temper of American life can be lifted by putting this knowledge into general circulation. But where are the interpreters with the training and the willingness to think their way through this knowledge and translate it into the language of the street? I raise the recruiting trumpet for the interpreters.

Among the sociologists who consider the extension of science to the adult public important, Professor William F. Ogburn, while skeptical about the possibility of getting large numbers of people to think scientifically, is confident that great masses of people are in need of help toward finding out what science contributes to a clearer picture of the world, to a sounder attitude toward the unknown, and general information about new ideas and discoveries, as well as practical information that is related to their daily activities at home or in their vocations.

Similarly, Lawrence K. Frank of the General Education Board believes that scientists have a special responsibility to help adults and adolescents to find new conceptions and ideas to replace the traditional religious beliefs about the nature of the universe, man's place therein, and the meaning and value of human life, which science itself has made untenable. Astronomy, geology, paleontology, and biology can and should provide the time perspective needed for a truly religious attitude toward the world and life so that the individual can relate himself to the ongoing processes of evolution and development in which man has so lately come and to which he can contribute through intelligent and hopeful guidance of human conduct and social development. For this purpose, science must learn how to convey meanings and create understandings rather than teach facts, formulas, and technical generalizations. Man desires larger conceptions and faiths with which to live and seek values and these must be consonant with and produced by scientific knowledge.[1]

Professor John Dewey considers the diffusion of science in a dynamic form an urgent need of the day. There is a need also to awaken in the public a demand for the available knowledge. At a dinner in honor of Dr. J. McKeen Cattell in Boston in December, 1933, Professor Dewey said:

> Hunger is lacking, and the material with which to feed it is not accessible. Yet appetite grows with eating. The trouble with much of what is called popularization of knowledge is that it is content with diffusion of information, in diluted form, merely as information.

It needs to be organized and presented in its bearing upon action. Here is a most significant phase of the obligation incumbent upon the scientifically trained men and women of our age. When there is the same energy displayed in applying knowledge to large human problems as there is today in applying it to physical inventions and to industry and commerce many of our present problems will be well on their way to solution.[2]

Another student of philosophy, Professor E. G. Spaulding of Princeton University, considers the cultivation of scientific attitudes in the population at large of great importance as a means toward reconciling criticism and resistance to convention with amenableness to social requirements.

Dr. Everett Dean Martin, who in many years as director of the Peoples' Institute in New York has had broad experience in bringing to large and heterogeneous adult groups the best thought from a variety of fields, observes that

. . . people want to know what is happening in the world of thought; they want orientation. . . . Science should be taught not in isolation, as separate subjects, but in relation to large human application. Such teaching should bring out the bearing of scientific findings on a civilised man's philosophy of life. . . . If science is related to the philosophical and social problems, we get a large attendance.[3]

Dr. Marius Hansome, who has made an intensive study of educational interests among working people, stresses the value of science education for the adult population in the possibility of transferring its methods and attitudes to social situations:

A relatively objective point of view is undoubtedly attainable in the social sciences, indeed, quite as much as in the biological sciences. It may be difficult to sustain an objective standpoint throughout the successive stages of: fact-finding, categorization, interpretation, and application. However, if account is taken of instances seemingly at variance with the provisional proposition, it should be possible to gather the factual data in a manner that is scientifically detached. A rational being might find it possible also to point out significances, meanings, implications, trends, without being under the compulsion of prejudice. Greater difficulties arise at the moment of the public announcement of a given truth, especially, if the newly discovered truth contains some unpleasant aspect of reality. If, for example, the social scientist observes a trend in the dynamics of society that points toward fundamental social change, and if he attempts, in his capacity of a good citizen, to get the public to face the con-

sequences of the signification, then the barometer of bias is likely to rise.[4]

In England in 1931 the Workers' Educational Association called upon the British Association for the Advancement of Science to form a joint committee to discuss the place of science in adult education. The Education Section of the Association took this up as part of the broader problem of the relation of science to social development and recommended the appointment of a committee "to consider the position of Science Teaching in Adult Education Classes, and to suggest possible means of promoting through them closer contact between scientific achievement and social development," under the chairmanship of Professor J. L. Myres of Oxford. The British Association had previously appointed committees on popular lectures and on other aspects of adult education, but here the initiative was taken by the Workers' Educational Association. In the 1932 report of this organization occurs this passage:

> If the important part taken by the Adult Education Movement in the national life is to be shaped in the light of the rapidity of the changes which are taking place owing to the increased application of scientific invention to modern production, it is essential that the education which it provides should be wide and liberal, and assign an adequate place in its scheme for the teaching of science. The Adult Education Movement cannot afford to neglect scientific thought and knowledge. Ignorance of the influence of science should belong to the past, and we can only be confident of future progress if we understand all the forces which are contributing to the reshaping of social life.[5]

Discussing social aspects of science, Sir Richard Gregory (who may, however, be classed as a scientist and presumed to have the normal bias of the scientist on this question) writes:

> The electorate must appreciate the general importance of scientific principles in every department of modern life and the necessity for trained intelligence guiding our administrative decisions and legislation, before it is likely to pay much heed to the representations of science on particular matters. . . . If civilisation is to be preserved, we must find a place in its direction for accurate knowledge and trained intelligence.[6]

While many besides scientists are strongly in favor of increasing science education among adults, there is by no means unanimity among the scientists. This negative attitude on their part is frequently noted. One scientist says, "Publicity hurts science. . . . The public is not entitled to know what the scientist is doing. Even the well-intentioned efforts of such bodies as the National Research Council interfere with the scientist. . . . The attempt to coordinate science only demoralizes the scientists."

Dr. Charles R. Stockard of the Cornell University Medical School, who has himself been rather successful both in writing and in speaking to the lay public, voices the attitude of many others when he writes,

> Much of what is called adult education is frequently lacking in accuracy and real understanding. Any education to be worth while, it seems to me, must be thorough enough and careful enough to expose the actual truth: and when it is modified and simplified to too great a degree accuracy and truth frequently suffer.

The emphasis upon accuracy and scrupulous regard for the verities is, of course, inseparable from the scientist's purposes and is a warning against a real danger rather than an objection to the wider diffusion of science.

From a totally different angle, Dean Guy Stanton Ford of the University of Minnesota raises serious doubts as to the place or importance of science in adult education.

> I find myself utterly at variance with . . . [the] assumption that the key to adult education and the crying need of a world facing problems of social adjustment is more leisure devoted to science. What we need is a knowledge of the impact of science on our individual and institutional life, knowledge of the social significance of science, not knowledge of or about science as such. . . . If any tolerable society is to survive, adults above all others need to know not more science as a way to social salvation but more of the implications of science for social institutions, more about the political, economic and social readjustments that they must make or *let* their children make. . . . Nobody today needs to have his intellectual gullet enlarged so he can swallow more unbelievable marvels of

science. We do that now without batting an eye. What keeps us socially and individually retching and in distress is the string tied to science and the things it drags along with it. I think we had better direct attention to the things at the end of the string. Our gorge rises now, meaning all our prejudices, intolerances, accustomed and inherited ways of thinking and acting, so that there are people who would have society stick its finger down its throat and get rid of science, at least temporarily.

Perhaps this view may be properly interpreted not so much as opposition to an extension of science in adult education as an appreciation of other needs that are more urgent and that those interested in "science" may overlook. Moreover, there is here more than a hint of resentment that the professional custodians and purveyors of "science" are in large measure without responsibility as to the human and social abuses to which science is put.

We value science because it means power. It is the ultimate attainment of man in his struggle with the obscure systems of nature. Man has always been "nature's recalcitrant son," in the words of Ray Lankester. He has always refused to submit and has always flouted her commands—more or less successfully. In modern times science has meant greater power to do whatever we wish to do; and with it we have transformed the whole world.

Science suggests at once, to nearly everybody, the great developments of technology in the transmutation of production, transportation, communication, illumination, sanitation, and so on. Science has transformed also every individual from a more or less competent and more or less wearied toiler into a pusher of buttons. To many who are not themselves scientists it seems reasonable to require that education include a familiarizing with whatever it is that happens when the button is pushed or the trigger pulled. But just as one can read time on a clock without any notion as to the mechanics of the pendulum, or any appreciation of the value of time, it is possible for all of us to learn to operate automobiles and radios and thousands of other gadgets without any concern as to what happens beyond the handles and

the levers. Yet the dean of a school of education can think of no better basis for a wide diffusion of science among adults than the assumption that such general knowledge would mean more satisfying, more effective, perhaps also more powerful, button pushing.

The obverse of this fallacy is possibly more illuminating. For example, we can imagine an excellent mechanical engineer who is not very skillful in negotiating traffic at a busy street corner. To understand all the parts of a motor car or radio, to be able to make minor repairs and adjustments, may be a valuable source of satisfaction, may increase one's efficiency; but such knowledge is not essential. What is even more important, such knowledge is not necessarily science.

To understand the mechanisms which man has created by means of his science is important for those who have to live with those mechanisms. To understand the world in which those mechanisms operate and exert their influence is important for those who live in that world; but not in the same way for everybody.

From numerous sources dozens of replies have been received to the question, "Why is science important for the adult population?" They turned out to be duplications or variations of some sixteen propositions as to the value of science in adult education.

These sixteen statements were submitted to the criticism of various scientists, educators, and "laymen" of several sorts. They appealed unequally as to their significance or validity, and some of them raised serious doubts. Some of the correspondents divided the sixteen affirmations into three or four groups; but on asking several trained men and women to classify the statements according to these categories, it was found impossible to get any agreements. The following classes were finally adopted for convenience, although they appear at once to be arbitrary and to leave several of the items straddling.

The diffusion of scientific knowledge and scientific attitudes among the general public is important for the following reasons:

A It would advance the individual's interests and well-being;
B It would tend to promote the civic and social interests; and
C It would advance the common or cultural interests.

[1] Conference, April 9, 1934.

[2] John Dewey, "The Supreme Intellectual Obligation," *Science*, March 16, 1934, pp. 240–243.

[3] Conference, April 9, 1934.

[4] Marius Hansome, *World Workers' Educational Movements*, Columbia University Press, 1931, p. 504.

[5] Quoted in B.A.A.S. committee report of 1933 meeting, p. 334.

[6] "Science and the Community," *Nature*, November 25, 1933, pp. 797–799.

II

SCIENCE AND THE INDIVIDUAL'S INTERESTS

1 *Usable knowledge affecting health, comfort, practical management of personal and vocational affairs is of direct help to everybody*

Science enables us to do more easily or more effectively whatever it is that we have to do in our daily conduct. This is generally recognized and a vast amount of usable information is thus demanded and furnished, even if it is not always reliable, or the best available.

A large part of the educational material that reaches the public as "useful" scientific information is of necessity dogmatic in form. It consists chiefly of practical counsel or rules, albeit supported by the findings of science. This is illustrated by rules of diet, advice on the care of children or pet animals, gardening suggestions, rules for removing stains from clothing or woodwork or for the extermination of insect or other pests. It is put forth by specialists who know their fields, as well as by writers who assemble information at second hand, or by lecturers who learn their lessons a little ahead of their public.

In being of necessity dogmatic, this "practical" kind of information is, of course, always subject to revision. Concern for calories or for a balanced diet gives way to concern for roughage or vitamins, following close upon the conclusions of the scientists who are constantly putting new ideas in place of the older ones. But being offered in the name of science, such teaching produces among uncritical adults two kinds of effects that seem undesirable.

First, it implies an assurance as to processes and relationships which the scientist himself seldom feels. He is confident as to

practical procedures even while seeking for refinements or eventually complete replacements of technical principles; but to the layman a procedure is right or wrong in an absolute sense.

In the second place, such teaching eventually discredits "science" because, unlike other orthodox teachings, it says one thing at one time and another thing at another time. With many men and women there comes a weariness in this constant change from the new to the newer, and a resignation to the old reliables that were good enough for our parents; science is only guessing, and a guess may be wrong as often as right.

It is notorious that the confidence and credulity of the public are constantly abused and that its ignorance is constantly exploited for private or partisan ends by methods that are identical, at least in form, with the methods used in sincere and genuine education. It may be necessary to expand the scope of school or college education to equip another generation to combat such unscrupulous assaults of propaganda and promotion, but for the present the "public," made up largely of adults, is in need of educational help from responsible and disinterested agencies.

2 *A better understanding of the nature of the world and of man makes for mental balance*

This is a claim that sounds plausible; but its validity depends altogether on the interpretation one makes of its terms. One correspondent is immediately reminded of eminent men of science who were anything but balanced mentally. An anthropologist points to the ignorant and superstitious primitives who never manifest any of our familiar neuroses. The assumption is that in a modern society, replete with stimulations and situations that make conflicting demands upon the individual, an understanding of the sources of conflict and of the significance of the various demands would make for greater stability. In the relatively simple case of Pavlov's dog with the induced neurosis, the difficulty lies in the animal's inability to discriminate

between the immediate stimulus and two others that call for opposite types of response.[1] The individual who recognizes the irrelevance of the confusing stimulus, or who has been made aware of the source of the troublesome signal, would presumably avoid the behavior characteristic of the mentally disturbed —unadaptive behavior resulting from "an unusually acute clashing of the excitatory and inhibitory processes, and the influence of strong and extraordinary stimuli."[2]

It cannot be claimed that a study of science will assure mental health: it can be claimed only that many kinds of fear and confusion can be avoided by an early habituation to the acceptance of reality.

3 *The material of science offers rich sources of aesthetic satisfaction*

The satisfaction which the pursuit of science yields to those who are engaged therein is often considered a warrant for urging a similar pursuit upon others. And there can be no question that the scientist does get from his preoccupation satisfactions of a kind that are at least analogous to those of the musician or artist. Aside from the handling of the natural objects or materials, their classification and identification, there is a constant stimulation of the imagination and of curiosity, the exercise of which yields genuine pleasure.

The "release from regimentation" which becomes necessary in an age of machine technology is being sought in aesthetic pleasures supplied by art, literature, music. But, for those who like that sort of thing, it is being sought and found also in science, in speculation, in the pursuit of the not-yet-known. For that also meets a human need quite as truly as do other forms of play.

> If within the modernized society individuals or individualism is to survive for those who do not sit at the levers in bigger and better central power stations, it must be sought by some in what we call the things of the spirit and in what for the mass of the people may be play and pleasure that are self-expression and freedom, touched if possible by beauty.[3]

But that is precisely what a free pursuit of an interest in some branch of science does for some people, and what a preoccupation with the flights of fancy in the company of modern physicists and astronomers does for others.

Pearson describes what we sometimes consider the highest reaches of scientific endeavor in much the same terms:

> There is an insatiable desire in the human breast to resume in some short formula, some brief statement, the facts of human experience. It leads the savage to "account" for all natural phenomena by deifying the wind and the stream and the tree. It leads civilised man, on the other hand, to express his emotional experience in works of art, and his physical and mental experience in the formulae or so-called laws of science. Both works of art and laws of science are the product of the creative imagination, both afford material for the gratification of the aesthetic judgment.[4]

For those who can find endless satisfaction in the study of science, it would seem that educators have nothing to do; there is, however, constantly the need to show those who cannot discover for themselves the endless possibilities what there is in science that concerns them.

4 *Leisure-time pursuits in some scientific field yield the satisfaction of growing power and have the further advantage of stimulating reflection, inviting orderly thinking and critical inquiry which may extend beyond the immediate subject matter with which the interest started*

The satisfaction which one derives from any freely chosen hobby is entirely subjective and not to be measured or judged by an outsider. Nor can we recommend one field of interest in preference to another: the subject has to make his own choice in terms of what stirs him to action, or to passive enjoyment. We can say only that science is not merely a possible source of aesthetic satisfaction, but it is sufficiently broad and rich to give the individual indefinite opportunity for growth—it is not a self-limited area of interest and is for this reason worth

exploring by any individual in search of certain kinds of adventure.

[1] I. P. Pavlov, *Conditioned Reflexes, an Investigation of the Physiological Activity of the Cerebral Cortex*, Oxford University Press, 1927, p. 290.

[2] *Ibid.*, p. 397.

[3] Dean G. S. Ford.

[4] Karl Pearson, *The Grammar of Science*, 3d ed., Macmillan, 1911, Part I, p. 36.

III

SCIENCE AND CIVIC OR SOCIAL INTERESTS

5 *The cultivation of systematic, accurate, and impartial study of natural phenomena should lead to the acquisition of a scientific attitude and to the dispelling of fears and superstitions*

We are disposed to expect as one of the results of a wider diffusion of scientific understanding and appreciation a sharp counteracting of mystery-mongering and obscurantism, whether calculated or ingenuous. But our efforts do not always bring the expected results. A distinguished botanist during his last years spent a large part of his savings on all the varieties of patent medicine that came to his attention. He was described by a colleague as "one of the easiest marks in the matter of buying and taking patent medicine."

It is apparently not sufficient to acquire the subject-matter content of some branch of science; perhaps not sufficient even to become technically proficient in the manipulation of materials, symbols, and processes in some special field. Experienced teachers of science in high schools and colleges are discovering the importance of avoiding indoctrination and of attempting "to get attitudes, outlook, methods, rather than detailed information." And the same need applies to adults. For education in general this need is brought out by Professors Dewey and Kilpatrick and their associates:

> The factors which have brought society to its present pass . . . contain forces which, when released and constructively utilized, form the positive basis of an educational philosophy and practice that will recover and will develop our original national ideals. The basic principle in that philosophy and practice is that we should use that method of experimental action called natural science to form a

disposition which puts supreme faith in the experimental use of intelligence in all situations in life.[1]

Science, whether as a study or as a body of knowledge, cannot make sure that those who are concerned with it will themselves benefit from it or make wise and humane use of it. Science itself is at the service of falsehood and deceit, as is the printing press—which was hailed as a great boon to mankind for its wonderful possibilities in spreading the truth! A long-distance telephone message directs a hundred newspaper editors how to distort a particular piece of "news"; nor is such use of the telephone confined to a completely coordinated Germany. Photography can be used to "prove" the presence of disembodied spirits. With the aid of mirrors we can "defy the laws of gravity." It takes good chemistry to devise good adulterations; but it is available—at a price.

Beyond providing the public with accurate and intelligible scientific information is the "much more difficult and vastly more important" task of developing "the habit of scientific thinking," according to the late Dr. E. E. Slosson. "The need is for greater appreciation of the experimental process by which the scientific principles are discovered or established." Otherwise we shall not be able "to distinguish between genuine scientific discoveries and the pseudomorphs, or fakes, in after-life . . . " or to "distinguish the man who knows from the man who does not know."[2]

6 *The study of science leads to an appreciation of human achievement—the history of science is a significant and exciting part of the great intellectual adventure of mankind*

Without some comprehension of what science has done to us, nobody can today find his bearings. Moreover, unless we are overtaken by chaos "the future belongs to Science," in the words of Sir William Osler. "More and more she will control the destinies of the nations." For such comprehension one need not know very much of the details of scientific procedure or of

scientific "facts." But for those who are concerned with the humanistic approach, science may not be overlooked.

On the other hand, science for many has to be deliberately humanized, that is, restated in terms that are significant for humanity at large, not merely for the scholar or the specialist or the technician. It is not to be expected that science will be restated so that all of "humanity" can grasp it; it is necessary only that the scientist or the teacher ask himself what this science means as a human pursuit or activity, what its findings mean as affecting mankind's outlook, what its results mean as affecting the quality of our living.

The adult layman confronted with the mysteries of science may properly demand that those engaged in education make clear to him the connection between scientific processes and results and other human interests and concerns—philosophy and religion, art and technology, government and subsistence, release from fear and the joy of living.

7 *An understanding of the methods of scientific procedure, whether in pure research or in industrial or other technical pursuit, is valuable for enriching and stabilizing our thought in common*

Rapid migrations of peoples have made almost every grouping so heterogeneous that there is a virtual confusion of tongues. The rapid distribution of "news" and ideas through the various means of communication has only added to the confusion. Differences in authorities, and especially differences as to the sources and meaning of authority, are fundamentally responsible for the confusion. If two men cannot agree, they can refer their dispute to somebody who knows. But science makes us perceive that there are certain matters which nobody knows, however much assurance any group may have as to the soundness of its own doctrines. Science proceeds, in fact, on the assumption that in specific areas the best we can do is to find out by trying. Hence the significance of assimilating the experimental method as a common way of life.

Science may be urged "for everybody" not in the confidence that it will give us common beliefs to guide us harmoniously always and everywhere, like the guiding principles of an established and accepted religious system, but rather in the hope that we can arrive at a common reliance upon the experimental attitude.

But if this experimental aspect of scientific method is truly significant for the common mind, it must be understood as something other than puttering or blundering through. This distinction, especially as it bears upon education and upon social attitudes, is emphasized by Professors John Dewey and John L. Childs in the following passage:

> If experiment means simply trying, there is nothing new about it. Life itself is an experiment; everything we undertake is experimental in one way or another. When the most assured dogmatist starts out to act in conformity with his dogma, he may have some private and subjective certainty as to the rightness and beneficence of his course. He may deem it absolutely warranted by the assured truths which he assumes that he possesses. But actually he is *trying* something. He cannot absolutely guarantee the consequences of what he does. His dogma will not guarantee them in fact. It will only blind his eyes to many bad results of his action and prevent his learning anything from what he does. The outsider, when he looks at the changes going on in another country, say Russia or Italy, spontaneously speaks of them as experiments, as trials. Even though they may seem to be something else to some of those engaged in them, that is what they are. In a world where there is as much complexity and contingency as there is in our world, it is true both that action is necessary and that action must be experimental, a trying.
>
> Experimental method is then something different from the bare fact of the omnipresence of uncertain trial in all action. The difference is that between experiment which is aware of what it is about and experiment which ignores conditions and consequences.[3]

Science, which has in the past destroyed so many orthodoxies, cannot attempt to establish a new doctrinal foundation for integrated social living; but the general acceptance of its methods may go far to weaken the rigidity of the various orthodoxies which, in their violent conflicts, destroy human beings and threaten to destroy civilization itself.

Without analyzing in detail the relationship between science and common outlooks, many scientists are aware of an impor-

tant connection. In the report of the British Association Committee on Science Teaching in Adult Education, this is indicated as one of the results of a wide canvass:

> The problem of stimulating the demand for science studies in Adult Classes is a matter for those who realize *the importance of the subject to the community generally* and understand *the serious danger to social stability that accompanies ignorance of the facts of science, or of scientific method.* . . . Several witnesses bear testimony that behind the apparent indifference to science suggested by the comparatively small number of classes, men and women are keen to learn when given the opportunity, and when they see that what is offered has practical bearings on the problems of life.[4] (Italics not in original.)

8 *Attention to the problems and methods of science would stimulate reflection and lead to a philosophy of life enriched by racial experience in which science has played a prominent and dynamic rôle*

It is generally agreed that, so far as it goes, the presentation of the practical aspects of science is pretty well done, in the various ways that have been suggested. It would seem to be no longer necessary to impress upon the general public either the wonders of the radio and the airplane or its debt to science for these and other marvels. It is desirable, however, to direct thought toward the steps by which mankind has emerged from the bewilderment of primitive magic to a fairly consistent theory of underlying relationships and of their investigation, and to such mastery of materials and forces as has made modern life possible.

9 *Whatever the motive of the learner, the cultivation of a scientific hobby is of potential social and economic value through the multiplication of observers over a vast territory*

It is recognized that the pursuit of "idle curiosity" or of a collecting interest is as legitimate an occupation for one's free

time as cultivating music or mastering a game; nor is it intended to set up comparisons of value that are in any way invidious. Science is not to be urged as a hobby against other possible pursuits, nor is it to be disparaged because in many cases it is superficial, or "only busy work." For those who like that sort of thing, the collecting of butterflies or mosses, or the watching of stars or birds through an opera glass, is a proper occupation; and the individual is under no obligation to justify his preferences.

In the broad field of "scientific" hobbies, however, there is to be found much of social value as well as of individual satisfaction if there is an adequate background for recognizing the significant categories of materials and behavior, and their relations to past knowledge and present needs. This is very well illustrated by the use which the Soviet Government is making of the elementary nature study offered in the schools. The children are made acquainted with common plants, animals, and minerals, and their economic or hygienic aspects are emphasized. From time to time a manifesto is issued calling for a survey in search of a particular kind of mineral or a particular insect or weed. Aside from the "regimentation" which is characteristic of much of the communist education, there is here suggested a potentially powerful means of carrying out common purposes under any régime. We have indeed applied this principle in much of our elementary and secondary education in this country. "Swat-the-fly" campaigns or bounties for tent-caterpillar egg nests or special lessons to help children recognize poison ivy are essentially of the same nature.

In the cultivation of outdoor interests in various aspects of nature, as through our National Parks, through local or state nature-study societies, through museum "wayside trails," and otherwise, there is opportunity to enrich as well as to dignify the activities by assimilating them to larger social problems. The British national land survey enlisted thousands of amateur volunteers for the gathering of prescribed information in their home territories. The Planning Committee for Mineral Policy

which was appointed by President Roosevelt in April, 1934, has among its problems a determination of the mineral resources of the country; and it should be possible to enlist the cooperation of an uncertain number of men and women who are already chasing minerals and who would be glad to convert their private enthusiasm into a national asset.

Amateur scientists have been important factors in the advancement of science, for there is no inherent reason why the amateur should be incompetent or inexpert. There is hardly a field of pure or of practical research in which they cannot make useful contributions, if there is developed a general appreciation for and trained skill in accurate observation and recording.

10 *Whatever may be the value of scientific pursuits to the specialists, and to the rest of us through the application of their outcomes or otherwise, they cannot thrive in a world of ignorance*

The chief obstacles to science have always been fixed ideas and vested interests. Reliance upon a body of doctrines that rationalizes an institution makes investigation a source of danger—to the institution. Orthodoxies of all sorts, whether religious or political, whether moralistic or intellectualistic, are inimical to the spirit of inquiry. The assurance that "the truth" is already at hand makes further search seem futile. Such obstructive confidence in the truth is well illustrated by the religious fervor with which many people hold and urge their theological doctrines. It is not, however, confined to this area but is characteristic of self-complacent ignorance in every realm of human thought. It is exemplified by the intellectual provincialism which assumes that those whose views differ from ours must be either foolish or dishonest, if not both; or which naïvely identifies its own sect or class or tribe or race or nation with God's chosen people, interpreting that mystic symbol of approbation, "O.K.," as meaning "Our Kind."

Science cannot proceed without the open mind, and the human mind, if not constitutionally disposed to close auto-

matically, is at least easily induced to shut up tight early in life. A major task of adult education is to reverse that process. An urgent need would seem to be to move as many as possible, and as early in life as possible, to adopt Cromwell's earnest appeal to his fellows: "I beseech you, my brethren in the bowels of Christ, remember that you may be mistaken!"

That research is important and calls for continuing support is sufficiently acknowledged in the fact that those who most immediately value research in industry or in government are already supplying financial support. The need is rather for a wider appreciation that will both furnish strong moral support and make impossible the crippling of significant research through the withdrawal of funds or equipment in times of crisis.

That this is not always recognized by scientists themselves appears from time to time in the indifference, if not hostility, displayed by the investigator toward "the public." Dr. Slosson referred to this in his address before the American Association for Adult Education in 1927:

> We have on the one side a public too often indifferent to the doings of scientific men. We have on the other scientific men who too often are indifferent to the public. There is an esoteric tendency in science as in all professional work. I was once, in talking to a distinguished scientist, deploring the popular ignorance of modern research. "The public does not know what is being accomplished in the laboratories," I said. "Why should they?" he retorted; "It is none of their business."
>
> This attitude is quite natural. It is no advantage to the investigator to be written up. On the contrary, it usually injures him in the estimation of his colleagues without gaining for him the esteem of anyone else.[5]

It is easy to point to men of genius who have in the past carried on their important scientific work with meager means and in the face of strong opposition. There is not in such facts, however, any justification for letting matters drift on the assumption that genius will find a way: that is depending too much upon the off chance that the individual who has the

capacity for valuable research is also one who has an independent income or an exceptional reserve of energy or the capacity to overcome social and other difficulties unaided. It becomes increasingly necessary to subsidize research in one way or another, and to furnish for it a congenial atmosphere of public opinion.

[1] William H. Kilpatrick and others, *The Educational Frontier*, Century, 1933, p. 62.

[2] "Adult Education in Science," Digest of Proceedings of the Second Annual Meeting of the American Association for Adult Education, May, 1927, p. 52.

[3] William H. Kilpatrick and others, *op. cit.*, pp. 307–308.

[4] British Association for the Advancement of Science Committee on Science Teaching in Adult Education, *Reprint* 32, p. 348.

[5] "Adult Education in Science," *op. cit.*, p. 49.

IV

SCIENCE AND OUR COMMON CULTURAL INTERESTS

11 *An appreciation of the achievements of science among the forces that have molded our daily life and our present-day economic, social, and political relationships would make for more reliance upon expertness in dealing with public questions, and less upon traditional authority or power*

Our age has been giving more and more regard to the individual as the embodiment of fundamental and essential life values. In this process the opinion which the individual is "free" to hold and express, and which sectarianism of all sorts constantly emphasizes, comes to play a large share in our daily relations, and especially in the social and civic relations. It becomes therefore of growing importance that people generally recognize the significant differences between opinions and beliefs, on the one side, and ascertainable facts and reliable guiding principles, on the other. A few years ago Dr. Robert A. Millikan, addressing a lay group, said:

> We need science in education not primarily to train technicians for the industries, but to give everybody a little glimpse of the scientific mode of approach to life's problems and to give everyone some familiarity with at least one field in which the distinction between correct and incorrect is not always blurred and uncertain, and to let him see that it is not always true that one opinion is as good as another.[1]

The need to make this distinction is apparent in the population at large and is to be observed in every field of human concern. It is obviously impossible for the individual, even for the specialist, always to be protected against "false" opinions solely on the basis of his own detailed knowledge. Reliance on the expert, and by so much on *authority*, becomes increasingly

necessary. But equally necessary is an appreciation of the source and basis of the authority on which one must rely; and above all is it necessary that the authorities themselves speak in a manner befitting the scientist. The most we can hope for the lay public is that through suitable educational efforts it will come at last to distinguish the voice and manner of the scientist from the voice and manner of those whose claims deserve no credence. Professor E. B. Wilson of Harvard University once expressed this as follows: "Science in adult education is important chiefly as a means of cultivating certain attitudes, and leads to confidence in the scientist who has this attitude, as against, for example, the politician."

A suitable introduction to the ways of science might bring a considerable proportion of our voters to doubting, if not their own, at least their neighbors' qualifications for public office solely on the grounds of belonging to the right party or having the right friends. And it might bring a considerable number to the point of asking relevant and disturbing questions of those who presume to tell us what is and what is not good for us to know, what may and what may not be properly discussed or criticized or investigated.

12 *Training in the rigorous method of science, in so far as the individuals are capable of it, should make for straight and independent thinking on common economical, social, and political problems in which it is particularly important to submit every idea to rigid scrutiny*

Perhaps nobody would deny the value of straight and independent thinking on our common problems; and many are confident that the study of science will normally bring about this result. Dr. C. Stuart Gager, director of the Brooklyn Botanical Garden, raises the doubt, however, by asking the question, "Is it not true that scientific men have been largely represented as among the 'easy marks' in connection with investing money in schemes that no experienced business

man would look at twice?" Nor does he believe that his own observation would support the idea that scientific men are conspicuous for their independent thinking on "common economic, social, and political problems."

Certainly it is true that thousands of men and women are thoroughly trained in the various branches of science and actually carry on reliable investigations, without being at all critical as to what is offered them by the salesman or the propagandist or the politician. Nor is it to be expected that the necessarily fragmentary and generalized science instruction that the lay public can get will make most adults more critical than are the scientists themselves. And yet the reasons for the failure may lie in the specialist's training and in his approach to the common problems; and the values in question may still be attainable for the layman even if the professional scientists, as a group, have not attained them.

The professional scientist, whether in research or in teaching, is typically a person who has received a rather extensive schooling, which included a variety of "subjects" in addition to the sciences from among which he eventually selected his line of concentration. In so far as he has mastered scientific methods in analyzing and solving problems, he has usually confined them to the area of graduate work and further specialization. The result has been in most cases that the individual has concentrated his intellectual efforts in the narrowing field, while disregarding developments in other subjects or while taking them for granted as being adequately looked after by other specialists.

Eventually, the specialist, proficient in his own field, comes to recognize his limitations and to refrain from forming opinions or making decisions when technical knowledge in a foreign field is involved, or else to use such intellectual skill as he has acquired in coming to conclusions on a foundation of more or less complete ignorance. Such a trained mind may have some advantage over the citizen who has not had the "benefits of higher education," for he has studied the elements of the social

sciences while at college a dozen to fifty years ago; but that may really turn out to be a disadvantage. He may remember the vocabulary and the "principles" that were passing current during his undergraduate days and be unaware of the changes that have taken place since that time, both in the realities around him and in the actual thinking of the specialists in the various fields. A business man or a person without so much schooling might have made a fresh attack on the problem at issue, or he might have gathered the best available information and ideas on the subject—as of the moment, not as of the past.

Now, the layman who wants to know what science can teach him with regard to current problems is more likely to keep before him those problems and to experiment with ideas as they bear upon the things that concern him; he is less likely than the expert to be complacent as to his past equipment and learning, although he may be more opinionated in other matters. An experimental psychologist may bring about among his colleagues radical changes in their outlook upon his special problems and yet cling tenaciously—and unconsciously—to sociological concepts that the present-day undergraduate recognizes as quaint antiques; or the engineer may be constantly experimenting not only with materials but with basic concepts in mechanics, electricity, chemical reactions, and yet retain a permanent "frame of reference" for all his political thinking.

That our higher or professional education does actually limit the specialist in these ways is suggested by the announcement of one of the outstanding schools of engineering. This lays down the usual argument for scientific training:

> Scientific studies develop . . . the habit of mind that submits every idea to rigid test. Much of the loose thinking in social, political, and economic affairs would be avoided if workers in these fields possessed real training in scientific thinking. The scientist and engineer have built the modern world, and they hold the key to its control and coordination.

Then we are told that this institution "offers a curriculum which joins the logic of science with the practical achievements

of engineering . . . all with due reference to the principles of economics." But that last clause is the crux of the whole matter, and it makes the argument look rather circular.

The school gives a rigid scientific training that includes a development of straight and independent thinking, the habit of mind that submits *every* idea to rigid tests; but it must relate the practical training of its students to certain fixed points in the external world. That is, it accepts certain ideas as given, as unalterable, as perhaps in themselves desirable. Students are trained to scrutinize some ideas; but the political, social, and economic processes and relationships are to serve as the bench-mark. The trained men who are to come from this school may be expected to apply their training in these fields; but the training in scientific scrutiny of ideas in these fields is explicitly excluded, not because they are of no concern to engineers, but because they are the foundations on which the institution rests. "Every idea" which the engineer is to test means not literally "every idea," but every idea in his area of technical competence. Nevertheless, we may hope to get important transfers of whatever is valuable in scientific thinking to the *common* problems from a candid interaction of scientists and laymen. Here the educational process is, of course, not one of transmitting information, but one of *mutual stimulation and exchange of thought and experience* and, above all, of humble self-criticism in the search for validity.

13 *Continuous contact with the progress of science would serve to bridge the gap between older and younger, essential for family and social integration*

Without minimizing the value of family and social integration, it must be pointed out that the sources of conflict and strain reach far beyond the details of common understanding as to the nature of the world or the workings of human contrivances. There is not only a great deal of internal friction in families or communities that are fairly homogeneous in their

beliefs and assumptions and practices; there is also to be seen a multitude of groups that are reasonably harmonious notwithstanding divergences in training and interpretation and values.

There is, however, a great deal of preventable disharmony that turns on conflicts as to usages, rituals, the implications of common terms, the manipulation of common materials or equipment. Here a continuing attention to the changes always in process, on the part of adults, would do a great deal to avoid misunderstandings and misgivings, besides furnishing numerous points of intellectual and emotional contact. It would at least retard that process by which the younger generation comes to speak a totally strange language beyond the comprehension of the older.

14 *An appreciation of the development of science as a great co-operative enterprise of mankind is likely to promote social solidarity and to make each individual feel a sense of unity with his fellows*

Here again we have to recognize not only large numbers of individual "scientists" who are temperamentally solitary or even anti-social in their attitudes, but also the systematic cultivation of scientific proficiency for partisan or sectarian purposes or for ends that are decidedly anti-social. And yet, if we get away from the absorption of the specialist to a broad overview of the continuing processes that constitute "science," we cannot escape its essentially social sources and outcomes.

It cannot be claimed that science today furnishes even the beginnings of a mass philosophy; yet no such philosophy will be possible unless it takes into account *the implications of science as to social relations*, both in its methods and in its findings. These implications are found in the very nature of science as an experimental approach to practical problems, and in the conflicting ideas with which mankind as a whole or in particular situations or groups is constantly confronted. Differences as to

opinions and as to procedures come more and more to be resolved, in a world of science, not by appeal to force or to authority or to the counting of noses, not by the matching of voices or the pounding of tables Such differences are taken to the laboratory and there submitted to pragmatic tests—controlled, measured, criticized, revised, retested. This means then neither that one man's opinion is as good as another's nor that any one person is the mouthpiece of God. It means that every voice must be given a hearing because every idea is worth testing, every criticism worth weighing. Moreover, it means that, whatever the outcome, it represents the joint product of a group's action. In contemplating the history of human thought, and especially the history of science, the layman is constantly impressed with the interdependence of scientists, with the wide area over which have been gathered the multitudes of ideas and suggestions and experiences and observations that enter into any important scientific conclusion. Those who have no appreciation of scientific conclusions, or who are for any reason hostile to science, may say truthfully enough that there is never anything "new" in science; all the elements of a new device, and all the elements of a new idea have existed prior to the discovery or invention. This is like saying that the artist or the musician never does anything new, he merely recombines what had been known before, just as Shakespeare merely rearranged certain of the familiar words of the language: it is just as true and just as meaningless. Science is a creative art, and its advancement depends upon the men of creative genius; but nowhere else is the individual so dependent upon others as he is in scientific pursuits.

The history of science impresses upon us also the striking lack of self-seeking on the part of scientists. A substantial part of the discussions among scientists in recent years has centered around the propriety of patenting inventions for private gain. There is still a great deal of confusion here because of the open conflict between the practice of industrial and commercial workers, on the one hand, and the traditions of the scholar

and the scientist, on the other. A Babcock knows that without the efforts of thousands of others, most of them nameless, *his* separator would have been impossible.

Science in modern times has accelerated the division of labor that began with the earliest association of two or more human beings; and this has called for the systematic elaboration of means for communication, transportation, and coordination, which in turn have been furthered by scientific methods and imposed still greater degrees of interdependence.

If the individual scientist had not been aware of the social and cooperative significance of his preoccupation with some detail of the universe, those of us who are not scientists must eventually have discovered that this tremendously powerful human engine somehow affects all of us and cannot be entrusted without control to those who happen to have it in hand. And those of us who are scientists will have to discover at last that we cannot continue our interesting pursuits without assuming more deliberately and seriously the obligations which are implicit in the sources of the power and opportunity which we enjoy. Science needs material support and moral support, but it also must have around it an atmosphere that is kept free not by toleration but by social participation.

15 *It is necessary for the general public to understand the function of the scientist in modern society*

If science is to continue as a mode of meeting common or individual problems, it will be necessary both for the scientists and for the lay public to have a clear idea of the function of the scientist. It has been sufficient to accept for the scientist a private subsidy, where his preoccupation has appeared amusing or harmless or at any rate far removed from common affairs. This has in the past put the scientist in the same position as a poet or musician or painter in a duke's retinue. Or a gentleman of means might pursue science as a rare pastime. Today the scientist still stands, in the minds of many people—and in

the minds of many scientists too—as a trained technician at the service of anybody who cares to hire him.

We have become today altogether too dependent upon science to permit the status of the scientist to remain so uncertain. Science is today indispensable in furnishing the basis for almost all forms of expertness; it is continuously used in ascertaining the factual means for planning of all sorts; it is the sole means for the mastery of our resources and for the combating of hostile conditions.

The "appreciation" of science for what it has done to enhance our material welfare may suffice to insure material support for the pursuit of science, if only from those who profit immediately from technological improvements. The aesthetic or intellectual satisfactions yielded by a contemplation of the methods of science may suffice to insure a place for scientific research in the universities and for science instruction in the schools, if only as a respectable part of what every cultured person should know. But a general realization of the rôle that science has played and increasingly must play in the remaking of civilization is necessary both to protect the scientist against exploitation for private gain and to insure to the public the enjoyment of our common heritage.

16 *Science is a means of broadening the sympathies and cultivating tolerance toward other groups, races, nationalities, tastes, philosophies*

While the pursuit of some branch of science almost automatically drives the individual into more and more remote reaches of his special subject matter, and the pursuit of science in general broadens our horizons by stretching the borders of the known, it by no means follows that a diffusion of scientific knowledge will of itself expand the sympathies of individuals. Even if science by its very nature calls for sympathetic consideration of many different views from many different sources, the individual is influenced by many other forces in

the formation of his tastes and especially his attitude toward strangers.

It is reasonable to expect, however, that the layman's concern with science will transcend the worst effects of narrowing specialization, that the questions which the layman wants answered will reach beyond the details that constitute the raw materials of science. We know that scientists, along with other classes, have manifested extreme provincialism and crude prejudice on occasion; but we are disposed to attribute such manifestations not to whatever science these men may have assimilated, but to human weakness not yet remedied by science or scholarship. The very fact that a whole world is shocked when scientists behave in such primitive manner indicates at least that most of us expect something more comprehensive in spirit to emerge from preoccupation with science, with its history, with its methods.

[1] *Science*, January 11, 1929, p. 30.

V

PEOPLE WHO NEED EDUCATION IN SCIENCE

SCIENCE concerns all adults, but not all in the same way. In all times adults have concerned themselves with improving their skills and understandings, with the discussion of matters of common interest, with learning whatever news was brought by the stranger or the traveler, as well as with local gossip. The need for keeping abreast of the world is no less urgent today than it was in the past, whether one thinks chiefly of his vocational security, of enjoying contact with what his neighbors are doing and thinking, or of his continuous adjustments in a changing society. Today the transformations of our world are in large part the outcome of scientific activity; and the need to keep in touch with these transformations is equally urgent for those who are themselves engaged in creating the novelties that keep our world changing.

ADULT EDUCATION FOR EVERYBODY

Our thinking about "adult education," where it is separated from vocational training, seems to suffer from the traditional associations with "English to foreigners," "Americanization," and "opportunity to make up." There is reason to believe that large numbers of high school and college graduates (including professionally trained men and women whose occupations rest upon the application of scientific principles) are quite as much in need of direct help and guidance in "keeping up with science" as are those who are admittedly without previous education in science. This is distinctly *not* a problem confined to the "underprivileged." Adult education must be concerned rather with method, with outlook, with appreciation, with the

assimilation of science as part of our culture, and with sharing in the ways of science.

Both the underprivileged and the exceptionally favored are among those for whom science has special meaning. At one extreme, penologists are finding a definite place for science in the educational work with adult prisoners. Mr. Austin H. MacCormick, Commissioner of Corrections for the City of New York, considers that a knowledge of general science "is as important as a knowledge of American history and vastly more practical."[1] At the other extreme are those who are so fortunate as to have the means and the leisure to pursue whatever pleases their fancy, and who happen to get their satisfactions from the pursuit of science, either in some specialized branch of research or in its general, social, or philosophical bearings.

An encouraging indication that we are outgrowing our childish complacency about our finished education is to be seen in the increasing proportion of men and women in university extension courses who have completed more than the high school work.

Another indication of advance is to be seen in the wide range of occupations represented in university extension groups organized around highly specialized subjects in pure and applied science, as well as in the nature study groups sponsored by museums, the educational service of the National Parks, and other agencies. Mr. Satterthwaite, chairman of the Adult Education Committee of the American Nature Study Society, has enlisted the enthusiasm of whole families in a well-to-do middle-class suburb of St. Louis. Dr. Vinal, in Cleveland, has been enrolling parents as well as teachers in his Nature Guide School. The variety in the membership of the astronomy club of the American Museum of Natural History is discussed in the next chapter (page 49).

In spite of the many uncomplimentary reflections on the way high school and college graduates do *not* reveal their cultural advantages, it is safe to assume that they actually do a large

part of the reading of serious books and magazines in every field. The canvass of university alumni made a few years ago showed a considerable desire for guidance in systematic reading, and the University of Michigan poll showed that 17 per cent of the preferences of 320 whose interests were cultural or avocational were in the natural sciences.[2]

CONSUMER'S INTEREST IN SCIENCE

The "lay" public comes eventually to include everybody. The most nearly universal concern with the applications of science is that of the "consumer," whose daily living is modified by what science is doing to our industries; and yet this concern is the most consistently neglected by most of the agencies that serve adult education in science. It is true that there are special courses on diet and nutrition, on the selection of clothing and furniture, on the care of the furnace or automobile. It is true also that the newspapers furnish a tremendous amount of useful and reliable information that is of direct value to the consumer—that is, the citizen at large who is in need of orientation with respect to the new processes, new devices, new commodities that "science" is constantly placing before him. Until quite recently, however, a large part of the instruction available, especially in newspapers, was almost entirely colored by the fact that those who publish newspapers were obliged to think of "the public" as made up not of people, not even of consumers, but of customers.

The necessity of interesting readers and holding subscribers and the equally urgent necessity of continuously getting advertisements have resulted, on the one hand, in stressing the picturesque and sensational in the news, including science news, and, on the other hand, in reducing the informational value of what is printed to the point at which it does not threaten to make the public critical. The result is obviously of the same order as a discoloration of the news for propaganda purposes. This does not necessarily mean a suppression of news, although it may—as when information regarding an epidemic

is suppressed because such news is "not good for business." It does mean a manipulation of the material on the assumption that, while the public may be harmlessly flattered with a little knowledge, it must not be given too much, or any that may injure certain special interests.

The consumers, as distinguished from the customers, represent the entire public and are therefore without any means of getting the kind of science that most concerns them unless they make use of the public tax-supported agencies, such as the schools, state or municipal universities, museums, and government-supported research institutes. And it takes a considerable amount of experience or training or exceptional insight for the layman to discover that he is not getting what he needs, or what steps to take to supply the deficiency.

At the Berkeley summer meeting of the American Association for the Advancement of Science (Section K, Social and Economic Sciences) in 1934, Mrs. M. G. Luck discussed the problem of regulating industry in the interests of the consumer, pointing out especially some of the great technical and administrative difficulties related to the correct labeling of consumer goods and to formulating standards of quality for such goods.[3] Apparently it becomes impossible for the individual to have enough knowledge to protect himself, and regulative means become essential.[4]

The specialization which makes some people scientists establishes the need for the layman to be concerned with the thinking of scientists, the meanings of new discoveries, new interpretations. But the same process of specialization makes it necessary for the scientist to be concerned with what other scientists are doing and thinking. Indeed, Professor Burton E. Livingston of Johns Hopkins University, for many years permanent secretary of the American Association for the Advancement of Science, thinks that workers in science may themselves be greatly benefited through the sort of education under consideration, and that it might be well for the devotees of science in its various special branches to have increased

opportunity for the cultivation of a general appreciation of science as a whole. The specialist no doubt "knows his stuff"; but in common with other specialists and with the "layman," he needs to know what his specialty means in relation to other specialties, or at least what the other branches of science and the scientific process mean for him and for his place in the world.

SCIENCE EDUCATION FOR PROFESSIONAL AND NON-PROFESSIONAL GROUPS

Those whose professional skills and judgments rest upon science are obliged almost automatically to keep abreast of their specialties by means of technical journals and books, by means of meetings and conferences, by means of special institutes and clinics, and occasionally by means of postgraduate courses, visits to institutions, field studies, or travel. Such continuous attention to new developments are largely in the sciences directly concerned. The alert minister and the professor of philosophy are also represented among those who feel a professional need for keeping informed on scientific developments. And, generally speaking, these groups are fairly well supplied with facilities adequate for their purposes.

Other groups that demand or are ready to receive educational assistance in science are industrial workers, whether organized independently as workmen's associations or under the direction of industrial management; granges or farmers' associations; cooperative groups; parents, especially mothers, concerned with the care of children. It is possible that some of the fraternal organizations and the so-called "service" clubs, disposed as they are to seek channels for the activities of their members along socially useful lines, might find in a more or less systematic attention to science and what it is doing to our civilization a satisfactory basis for some of their programs.

Interested in providing education in special phases of science to the public at large or to special sections of the population are various voluntary benevolent or welfare organizations, such

as the safety councils; health and tuberculosis associations; societies for the prevention of blindness, or for the hard of hearing; committees on maternal health, and so on. Educational assistance in science for teachers in service is generally available in urban centers that have institutions of collegiate or university rank, but teachers' organizations in general are not sufficiently self-conscious, professionally, to further systematic education for their members in a way that makes concern with science a normal part of the individual's intellectual life. Science teachers have been organizing more and more along professional lines and are increasingly expecting of one another the regular reading of scientific magazines, as well as of educational ones, and are supporting three or four magazines devoted exclusively to the teaching of science or of special branches of science. They also have numerous local and regional organizations that meet annually or more frequently for the consideration of the professional and more general aspects of science and of education in science. At the Pittsburgh meeting of the American Association for the Advancement of Science (December, 1934) definite steps were taken for the formation of a national organization of science teachers.

DISINTERESTED TEACHING

In the professional as well as in the non-professional types of organization the activities designed to further science education among the members are likely to be combined with certain ulterior purposes, and the education is likely therefore to be restricted to special knowledge or even to special dogma. It is not on that account to be disparaged, yet the need for something more comprehensive or penetrating has to be emphasized, since there is always the danger of perpetuating the traditional teacher-pupil relationship, which is of diminishing value in adult education and especially in science.

Popularization of science must be sincere and without ulterior purpose, as, for example, that of promoting a commercial product, a sectarian doctrine, or a political theory, whether

"radical" or "conservative." Such diffusion of socially useful but disinterested sciences depends upon the cooperation of the scientist; and this in turn depends upon the confidence which the scientists have in the teachers or popularizers, as well as upon their attitude toward the public, for the confidence of the latter is no less essential.

MUTUAL ATTITUDES OF PUBLIC AND SCIENTISTS

A certain indifference, not to say hostility, on the part of some scientists toward the public, has been frequently noted. There is, of course, a corresponding suspicion, and even hostility, on the part of certain portions of the lay public toward the scientists. This is quite apart from the emotional accompaniments of the various doctrinal disputes that have from time to time involved scientists and other groups. It is rather the outcome of the conviction, on the part of many workers, that the powers which science yields to mankind are being unduly appropriated by the privileged classes, and that the scientists, the research institutions, and the universities in some way conspire to the disadvantage of the workers. This is discussed by Marius Hansome, who characterizes as "the height of folly" the indiscriminate condemnation of universities and university extension divisions on the ground that many university departments harbor illiberal defenders of existing injustices. From the larger social point of view these mutual suspicions and animosities are worse than unfortunate: they are inimical to the interests of all concerned. Scientists and educators would probably agree with Hansome when he says that "society has nothing to lose by fostering objective search for truth and its communication." As for those who "want to apply the fruits of research to human welfare . . . and who are impatient with the universities," Hansome says further, "it would seem the part of wisdom to train their broadsides against the reactionary forces that would stifle freedom in the objective pursuit and diffusion of truth. . . . Objectivity matters far more than impartiality."[5]

Those engaged in educational work must themselves be steeped in the spirit that makes science significant for the general public. There is thus placed upon the teachers as a body (not merely the teachers of science) a responsibility that extends beyond the need for knowing their subjects and the techniques of teaching. Science is of sufficient social importance to warrant the serious and systematic attention of teachers, as adults who play an influential rôle in the community of adult thinking and in the determination of adult attitudes, and, by the same token, of all intellectuals who are engaged in modifying the social processes and relationships.

There is finally the need for making concern with science and its meaning a conscious part of the statesman's task. In an editorial that appeared in *Nature* last year, this need is clearly stated:

> The administrator and statesman have to learn of the scientific worker to bring to bear in the affairs of State the outlook and method of ascertaining facts which are characteristic of science, and to assist in the evolution of machinery or organization through which the technical expert can exercise his proper influence and policy, whether in national or international affairs. Already definite progress is being made towards functional self-determination in various spheres, and once the work of educating society to the place of science in the new order is well in hand, the organization and functioning of the State should become more scientific, impartial and business-like, and less political in the old partisan sense.[6]

Science is for all adults who can be reached with it.

[1] Austin H. MacCormick, *The Education of Adult Prisoners*, National Society of Penal Information, 1931, p. 54.

[2] Wilfred B. Shaw, *Alumni and Adult Education*, American Association for Adult Education, 1929, p. 44.

[3] *Science*, July 20, 1934.

[4] T. Swann Harding, *The Popular Practice of Fraud*, Longmans Green, 1935.

[5] Marius Hansome, *World Workers' Educational Movements*, Columbia University Press, 1931, pp. 502, 505–506.

[6] "Science and the Community," *Nature*, November 25, 1933, pp. 797–799.

VI

ADULT INTERESTS IN SCIENCE

THE objectives of education have to be differentiated from those of schooling. Adult education is an expression of the purposes of the individuals being educated. It is "free" in the sense in which our universal public education is not free. The latter, when taxes are collectable, is supplied to the individuals without direct charge; it is free only because it is without price. Such education is, however, for the most part also compulsory, which is just the opposite of free.

The education of adults, in contrast, is altogether free in one sense, and a very heavy charge or expense in another. It has to be voluntary. It has to be wanted sufficiently to warrant considerable effort and outlay of money, if necessary, which means also effort and often sacrifice. Adult education must in its form take on a greater variety than anything we have as yet thought of providing for children.

GIVING THE PUBLIC A CHOICE

It is not customary for the editor to ask his readers what they want; and it is not often that directors of courses or classes ask their public what they want. We draw inference as to the public's preferences from indirect evidence; and generally speaking an experienced editor or educator comes to approximate the public's wishes through shrewd guessing. If an announced class fails to bring in enough enrollments, the class is withdrawn; and if the class repeats its failures, it is eventually dropped. If there are excessive enrollments, additional sections are organized.

In some university extension organizations and city school systems there is opportunity for initiative on the part of the prospective students: if ten or a dozen or fifteen request a class in any subject, effort is made to find a suitable instructor and a class is formed. In a letter (see page 147) Dean Chester D. Snell of the University of Wisconsin writes, "The Extension Division is ready to meet any articulate demand in the field of science teaching for adults." In other systems the offerings remain rather stereotyped year after year, determined by the traditional concepts of the leaders as to what constitutes "education" or as to what is good for the public. Where there is considerable freedom of choice, and where the range of offerings is reasonably broad, and especially where there is opportunity for the public to make suggestions as to desirable courses or classes, it may be assumed that the public's interests are being satisfied. If then the proportion of time that adults give to science is less than was formerly the case, or if it is true that "our high school and college graduates care generally less about science than about athletics," the reasons must be sought elsewhere.

PERSONAL PREFERENCES

An attempt to enumerate the kinds of science classes or courses offered at once brings out the fact that specialization has overtaken not only the professional scientist who has divided up his tasks into manageable units, but also the layman who finds an interest in some minute fraction of the total task that "science" has set for itself. The identification of birds, the breeding of hybrids in the garden, the mounting of butterflies, the trying out of different kinds of bait or "flies" in fishing, the tracing of musical motifs from the symphonies in folk songs, the classification of plots in murder mysteries, or the calculation of the orbits of billiard balls may be amusing pastime, serious hobby, or devotion to science.

The collecting interest which shows itself during childhood in the indiscriminate gathering of unconsidered trifles may become

an extremely technical exploratory or museum occupation, a specialty in astronomy or mineralogy, or a highly refined technique in the classification of bacteria or isotopes. The aesthetic interest in form may come in time to operate in an authoritative expert on fossil teeth or chromosome maps. It was as much the artist as the scientist in Goethe or Cuvier that evolved morphological concepts. The interests that bring people to the pursuit of science, in any form, are of infinite variety.

In a study of some five thousand extension students at the University of Minnesota it was found that two-thirds of the men and women were studying for advancement in their work. Besides some 4 per cent with miscellaneous motives, the rest were about equally distributed among those preparing for a different job, those having cultural or social reasons for their study, and those who were using this way of employing their leisure time. When classified according to age, these students showed much larger proportions interested in vocational aims at the lower age levels, as is to be expected, since "there are few persons above fifty years of age who hope to advance in their work." This information was not analyzed with reference to the various subjects or departments of study, but the group as a whole was enrolled in courses of collegiate rank.[1]

In a university extension center in a large city an attempt was made to find what brought the members of a chemistry class together. Some were already occupied in chemical laboratories and wanted to increase their technical proficiency. Others were at work in various industries that made use of chemical processes and hoped to advance themselves vocationally. Several women were teaching in the junior high schools and felt the need for some chemistry to enable them to hold their own with a new program in "general science." Other teachers (and some not engaged in teaching) took a course for credit in a belated effort to acquire a collegiate degree. And finally there were several men (all with college degrees, some with advanced degrees) who came because of some curiosity as to the subject matter.

The work of this class followed closely the plans and methods of a parallel class on the university campus. The instructor felt that if there were time and facilities it might be advisable to differentiate the selection of topics and the method of instruction to serve the needs and interests of the several groups of which the class was constituted; but that on the whole the academic course represented the largest common denominator and served as a solid foundation for any further study which the individuals might later care to pursue.

This situation is probably typical and raises some doubt as to whether a closer adaptation of methods and materials to the interests of the adults might not find larger numbers ready to give considerable time and effort to the study of the sciences.

WHAT SUBJECTS INTEREST THE PUBLIC MOST?

In his address on "Adult Education in Science" before the American Association for Adult Education in 1927, the late Edwin E. Slosson made a point of the fact that people's attention to science is quite as disinterested, in a material sense, as their attention to art or music.

> We have just concluded a survey of the use of our syndicated material by clipping and classifying the articles published during the month by a selected list of more than forty newspapers in various parts of the country. We send out every day five or six brief articles on various scientific subjects from which the editor of the paper selects one or more for printing in his paper. The results of the survey are upsetting to certain traditional ideas of popular taste. It is commonly supposed that the average man is most interested in reading about what concerns him most; that he is after practical information which he can apply in his business or daily life, and that he disdains whatever is useless and remote from him in time and space. Yet two sciences that stand in the top group of the list in order of popularity are two that are most remote and impractical of all, archaeology and astronomy.[2]

On the other hand, the Committee of the British Association for the Advancement of Science on "Science Teaching in Adult Education" concluded from a canvass of men in charge of lecture courses and tutorial classes that the biological studies

appealed most to the adult population generally; and while the biological studies are not here closely related to the vocational interests, they can hardly be considered remote and impractical. Indeed, we have found considerable evidence that the interest in biology is generally rather immediate and close to a real concern, not only as to physical health, but also as to the facts of reproduction, the meaning of sex, the principles of heredity, contraception, and so on.[3]

It is easier to reconcile the divergent conclusions from the two studies than to get a significant indication of what the public does want. Dr. Slosson's tables were based on what the editors of certain newspapers most frequently selected from among the items submitted by Science Service. The selection may truly reflect what the public most wants to read about. But it may indicate only what the editors (*a*) think the public wants; (*b*) estimate as worthy of printing; (*c*) consider "safe," in view of the prevalent fears and taboos and superstitions. The findings of the British Association committee are at least more direct.

The stars seem always to arouse the kind of curiosity that leads to systematic study, and for a very large part of the adult public they remain a constant source of wonder and awe. From the time of the opening of the Adler Planetarium in Chicago, the interest of the public has been continuous. The Fels Planetarium recently installed in Philadelphia promises to repeat the same experience. The telescope of the Franklin Institute, which is open to the public on all clear nights, is constantly in use. The telescope at Northwestern University is open to the public Thursday evenings and entertains some three thousand visitors a year, who "ask many questions and take out books."

The Amateur Astronomy Group of the American Museum of Natural History, consisting of several hundred members, meets regularly to study the stars and to hear lectures and see pictures. They have succeeded in getting most eminent professional astronomers to speak to them as well as in working up

programs through their own membership. Although no attempt has been made to analyze the personnel of the membership, it is observed that the composition is rather heterogeneous, and quite different from that of the museum membership. A great deal of technical information is acquired through such activities and this furnishes a foundation for sound understanding of specialized phenomena.

SCIENCE AND SUPERSTITION

These examples are illustrative of a widespread interest in the stars and in a study of the stars; but the "interest" is not unitary. We must not be surprised to find that the command of authentic knowledge developed in such groups may go hand in hand with superstitious thinking in fields not even very remote. An excellent engineer will patronize an osteopath rather than a "regular" doctor because the "theory" of vertebral dislocations as a source of morbid processes "appeals on engineering grounds." During the Century of Progress Exposition in Chicago (1933) the Adler Planetarium had a record attendance; but so had the shops of the fortune tellers and astrologers close by. In fact, there was a strong suspicion that the marvels of science intimated by the planetarium gave support to the confidence with which the public consulted the astrologers. The public will turn to science if that stirs the imagination or arouses wonder or presents something startling, just as it will turn to magic or mystery plays.

SEARCH FOR CULTURE

Generally speaking, science courses and extension classes were introduced in the first instance as helpful technically or vocationally—knowledge of certain kinds was recognized as useful. But aside from the individual curiosities or traditional respectabilities which more learning could further, there has always been a feeling on the part of large numbers that they were handicapped by lacking something in education that gives a peculiar kind of power, something that the privileged seem

to have, something different from technical knowledge or partisan doctrine, different from the commonplace gossip about celebrities or conventional beliefs about the world, about mankind, about things in general, about destiny. For this something elusive there has been more and more demand, some of which seeks its satisfaction in a study of science.

It is difficult to distinguish some phases of this quest from that which has been belittled in other areas of activity as "keeping up with the Joneses." When the parents of the students in a large high school attend outline courses that are offered to help "keep up with their children," or when a group of club ladies engages somebody to review the season's plays for them, they are doing essentially the same kind of thing as does the engineer at an isolated post who subscribes to a technical journal or a metropolitan newspaper. Keeping-up-with is a normal manifestation of our incorrigible sociability and is a legitimate motive for many of the foolish things people do as well as for many of the sensible ones.

In his 1927 report as director of University Extension of the Massachusetts Department of Education, James A. Moyer says:

> During the past few years there has been discernible an increasing interest in the cultural courses offered by the Division of University Extension. It has not been the province of the division so much to account for this tendency as to respond to it. It may be plausibly maintained, however, that the trend toward vocational courses, which was so pronounced a few years ago, is now reversed and people who desire more education are turning again to the subjects which appear to yield a larger spiritual and intellectual return. Or, it may be said that the interest in vocational courses before and during the world war was largely inspired by the desire for higher wages and that now, when wages have been considerably increased in most occupations, our people have turned to studies which foster living rather than a living.

That report, however, was written before the great economic reversal. It would seem worth while to ask what unemployed men and women do with their free time educationally when

there is no opportunity in sight to convert more "education" into more income.

Two related kinds of interest in science are becoming especially recognizable. One of these may be called recreational. This is a frank acceptance of the new leisure, whether "earned" or imposed by external circumstances, and a frank use of it as a legitimate occasion to follow the play of fancy or to ride a hobby. The other is a serious concern with the connection between science and what is happening to our civilization.

CONCERN FOR CIVILIZATION

Professor Dewey observes "some signs of a rebirth of the educational interest that marked the Greeks who thought of [education] . . . chiefly in terms of adults." There was never a time in the history of the world, he continues,

> . . . in which power to think with respect to the conduct of social life and the remaking of traditional institutions is as important as it is today in our own country. . . . The chief obstacle lies not in the lack of information that might be brought to bear, experimentally, upon our problems. It lies on the one hand in the fact that this knowledge is laid away in cold storage for safe keeping, and on the other hand in the fact that the public is not yet habituated to desire the knowledge nor even to belief in the necessity for it.[4]

We should expect that in a time of unusual strain people would become confused and suspicious of what they had been taught to believe as true explanations and as correct standards of the life around them. They would grope for something more fundamental and more satisfying than the concepts and categories that had previously passed unchallenged. People are aware of gaps, not alone in their own knowledge, but in the current stereotypes of their associates and even of the authorities. They turn to science as one possible source of needed knowledge, one possible source of answers to the questions that beset them.

[1] Herbert Sorensen, *Adult Abilities in Extension Classes, a Psychological Study*, University of Minnesota Press, 1933, Chap. V.

[2] E. E. Slosson, "Adult Education in Science," Digest of the *Proceedings* of the Second Annual Meeting of the American Association for Adult Education, 1927.

[3] British Association for the Advancement of Science, Committee on Science Teaching, *Report* 32, p. 348.

[4] John Dewey, "The Supreme Intellectual Obligation," *Science*, March 16, 1934.

VII

THE CONTENT OF SCIENCE FOR THE LAYMAN

THE content or subject matter of science in adult education forms an irregular block of ideas. One dimension of this block is the entire range of motives that bring men and women to a consideration of science. A second is the entire range of topics or problems that occupy the attention of scientists. And the depth varies with the needs of individuals, their drives, their desire to follow an interest to the limit.

This view gives us at once an important practical distinction based on the amount of time given to educational activities. Short courses or even single lectures or pamphlets can serve a specific need in practical application or in reorientation: how to locate Encke's comet, or how to recognize the Dutch elm beetle; new findings in genetics or in immunology; the principle of indeterminacy or the ninety-third element.

Then there are more or less systematic courses of instruction that are virtually parallel to the academic organization on the secondary or collegiate level. The desire for this type of education may be met by university extension or evening high school systems or by resident courses in late afternoon or evening hours in the usual institutions. And they are commonly offered under designations corresponding to the familiar branches of the natural sciences—physics, zoology, astronomy, geology, psychology, and so on. Such courses would seem to take care of themselves in the sense that schools and teachers, on the one hand, and prospective learners, on the other, can get together in terms recognizable by all concerned.

Then there is the intensive and prolonged pursuit of a special interest as a major avocational concern, whether in the field

or laboratory, whether alone or with expert aid, whether individually or in a group.

The distinction as to the intensity or as to the extent of the educational effort is important for practical purposes, but all degrees of application are legitimate; they serve different needs, and there is no reason for thinking of the distinctions as invidious.

The present need seems to be to define more clearly the place and the functions of non-academic and non-vocational activities in science education. These would include a relatively small proportion of information or technical skill among the objectives, and a relatively large proportion of application and interpretation, and special attention to the critical consideration of attitudes.

EVERYDAY SCIENCE

The Committee on Continuation Education for Adults, of the National Commission on the Enrichment of Adult Life of the National Education Association, makes a place for "everyday science" in its report (Washington, 1933). Of this the committee says that it

> . . . develops an understanding of the scientific background of the more common phenomena of nature. It explains the practical application of science in the home, in industry, and in the community. It stimulates the desire for further knowledge of, and lays the foundation for a further study in, science. Among the chief topics which should receive attention are the following: (1) The Weather; (2) Electricity; (3) Food and Air; (4) Rapid Communication and Transportation; (5) Water; (6) Fire.

Adults without special knowledge are baffled by the various mechanisms and are sometimes humiliated in the presence of youngsters who easily manage the new devices, or who glibly discuss pressure areas in relation to the weather, dominant or recessive genes, and call the vitamins by their names. English observers also agree that there is both a demand for such direct introduction to the science of common experience and opportunity for effective teaching: the wireless, a motorcycle,

photography, domestic pets serve as the starting points from which systematic scientific studies are sometimes developed to rather high degrees of elaboration. "In all these classes the instruction is at once practical and scientific. Rule-of-thumb is discouraged, and the object is . . . to proceed from practice and observation to general principles and thence to the application of principles."[1]

There is need for a more widespread understanding of the scientific principles that lie hidden in the everyday appliances; but we are living also under restrictions and interferences from "science," the reasons for which are far removed from common sense. A clarification of the principles involved would undoubtedly bring genuine satisfactions to many men and women who are not able even to formulate their desires. Quarantine and vaccination, for example, are frequently the sources both of fear and of resentment. It would be desirable to have them generally understood as principles that command cooperation as a matter of course.

From the point of view of the statistician or of the administrator who can report improvements, this distinction may not be significant; but from the point of view of the statesman, however, who can anticipate increasing demands made upon officials and bureaus and increasing resistance to regulation and regimentation, this should be important. It is at any rate worth considering whether there is not a great deal to be gained through a more universal familiarity with the scientific principles by which administration and ordinary living must be increasingly guided, and with the methods by which those principles are reached.

There is another aspect of "everyday science" that deserves attention. This is the wide prevalence of superstitious attitudes and of underlying assumptions about things in general which interfere with a rational approach to new problems and with the best use of new knowledge. Many of these irrational "beliefs" and attitudes are especially resistant to educational effort because they are labeled "religious"; but they have

really nothing in common with religion except strong conviction and an element of fear. Belief in the roundness or flatness of the earth, for example, or in vegetarianism or in sympathetic magic or in the doctrine of signatures is not in any sense a religious essential. It is conceivable that an introduction to the methods by which science has handled a variety of problems arising out of everyday living may serve to reorient people in some of their fundamental concepts.

Finally, it is well to consider the effect of the rapid introduction of new devices and new practices among people who do not understand the underlying principles involved. Where these new usages and ideas become current or uncritically accepted and acquire sanction in the name of science, there is the danger of developing a new credulity that does not differ essentially from old superstition. The mystery of radio becomes a scientific basis for telepathy and absent treatment; practical aviation validates the myth of Yogi levitation; the principle of indeterminacy gives scientific demonstration of the freedom of the will; and in general wishful or fearful thinking can find support in one or another "scientific" notion or device. And the acceptance of usages sanctified by science, in the absence of any appreciation of the underlying principles and limitations, leads also to the fixation of ritualistic observances that tend to obstruct further growth. A legitimate caution against bacterial infection may degenerate into formal cleansings or a morbid obsession; the lime juice which the British statute required all boats to carry as a protection against scurvy was replaced by a commercial lime juice that lacked the essential vitamin C; the demonstrated value of ultraviolet light furnished a market for expensive but worthless glass or brought about injurious exposure to sunshine; fumigation continued long after its futility was demonstrated.

The newspapers normally diffuse a great deal of information about new applications, new practices, new ideas arising from scientific research; and much of this information has a bearing on everyday affairs. Indeed, the most effective publicity is

that which makes a direct association between a new idea and what is already familiar, notwithstanding the emphasis on the novel and strange. The interest of the public is like the explorations of a young child who is trying to see how far he can go without losing sight of his home. In certain respects the popular interest in science, like the professional interest, is a play interest. But to call it a play interest, or to say that it may have no relation whatever to an "understanding" of a subject, is not to belittle it. The interest in the curious or the novel is legitimate on its own account; and it often leads to preoccupations that may develop into serious efforts toward understanding. Even where it is impossible to reach full understanding, however, educational efforts along these lines are needed.

HUMAN AND SOCIAL APPLICATIONS OF SCIENCE

Somewhat different from the everyday science is the recommendation from many sources that adult education bring about an appreciation of science in "relation to life," or in its human, personal, and social applications. Thus the committee of the British Association on the position of Science Teaching in Adult Education concludes from its studies that science courses should deal "frankly and simply with the real issues of life"; and that when they do so, classes are well attended, voluntary clubs or societies are formed for further study, and that such groups do good work along both "scientific and social lines, in the most unlikely neighborhoods and often under very discouraging conditions."[2]

Most people, it may be agreed, are not interested in botany or in zoology, as such, but they are interested in the human and social applications of botany and zoology. Most people are not interested in data, but they are interested in principles and generalizations. Julian Huxley is quoted by the committee as urging that "industrial work should be more directly linked up with its scientific basis; scientific work and invention should be encouraged among workers in factories, and knowledge of

the scientific basis of the processes on which they are employed should be made more accessible to such workers."[3]

The social applications of the biological sciences are repeatedly brought forward by many observers as of prime value in adult education. Dean Willard C. Rappleye of the College of Physicians and Surgeons in New York, who has made a deep and extensive study of medical education, recognizes the need of continuation education for the professions but writes about the lay public, "We also are keenly interested in the possibility of educating the public at large to a sounder and more active appreciation of the needs and recognition of sound medical practice in the various specialties as well as in general medicine, child care, preventive medicine, public health, et cetera."

Dr. Paul Popenoe, secretary of the Human Betterment Foundation in Pasadena writes, "One of the most important phases of adult education at the present time, is that dealing with the problems of marriage and parenthood." This refers to problems in the biology of sex, heredity, the selection of a mate, birth control, personal and family health, social hygiene in the broadest sense.

The biology of sex and a wholesome attitude toward sex as a normal part of life are frequently mentioned as needed elements in adult education. "No subject can be more important than the teaching of young married people how to manage marriage successfully; and the teaching of parents how to teach the children the best healthy normal view of sex . . . the view of the biologist who must view sex as the normal and healthy and clean joy of living."

Demand for more science in parent education is indicated by such observations as those of Miss Florence E. Winchell, specialist in parent education and child development under the Board of Education in Rochester, New York:

> After two or three years of work in parent education, women become much interested in widening their field of study. They sense the need for more scientific information with the idea of interpreting

the child's environment to him intelligently. This would suggest courses in general science [for parents] . . . also enough of the more advanced work in science to make them more intelligent regarding their household equipment and the interests of their adolescent boys and girls. . . . Other fields . . . are those of heredity and the physiology of reproduction . . . nutrition . . . psychology . . . child development.

The study of human biology is reaching out in many directions and promises to yield practical results for the individual and for the community; an acquaintance with the fundamentals, the problems, and the methods of this study can be made interesting and profitable to increasing numbers of men and women.

GENERAL SCIENCE

There is fair agreement that the adult public that has not had much opportunity to acquire science is best introduced to the study through a broad approach, such as nature study. One experienced leader in the Workers' Educational Association writes to the British Association Committee on Science Teaching in Adult Education, "It is found desirable to begin, not as physics or chemistry, or biology, but with a mixed elementary introduction to all these."[4] Even for more advanced students there is need for an organization of materials that cuts across the traditional divisions, as, for example, genetics, physiology, ecology, parasitology, paleontology, in contrast to botany or zoology. And this view is in harmony with the demand for "everyday science," which approaches through familiar complexes that embody the results of many branches of science—the internal combustion engine, the garden, photography, and so on. This is perhaps another way of emphasizing the fact that the various special branches of science are not elementary but highly sophisticated abstractions: the beginner experiences life in larger wholes, the scientist analyzes for his own purposes, which need not necessarily contribute to facilitating the efforts of the learner.

One of the obstacles to a wider diffusion of science among the lay public has already been suggested in the fact that the scientist is usually a specialist, and, even if a teacher, then in one of the higher institutions, so that it has been difficult to get instructors who are both equipped and interested to deal with the broader point of view required. That this indicates a widespread condition may be inferred from the fact that more and more colleges have been trying to organize courses in the general principles, assumptions, methods of science for those students who are not likely to pursue the study very far. Among many college students, that is, as well as among adults generally, there is very little technical interest or specialized concern in science, and yet a need to know something of the genesis of modern thinking, its importance, its bearing upon practical affairs wherein individuals have to make personal or civic decisions, as distinguished from technological applications in the various practical arts.

In an address before the British Institute of Adult Education, Sir Benjamin Gott affirmed the need for "more men who have wider knowledge of the different branches of science and know more about the interrelations of those branches; . . . it is time we began to teach science and not chemistry, or physics, or biology."[5]

METHODS AND ATTITUDES

Increasingly educators, and the public generally, recognize that the business of education, so far as knowledge is concerned, is not to fill the individual with information that will some day be useful, but to equip him to find the knowledge he needs when he needs it. In adult education the same holds; and in science education there is a special need to get the learner to distinguish the knowledge and conclusions as of a certain date from the attitude which recognizes the problems and approaches them with the methods characteristic of science. This distinction is illustrated by a quotation from Mr. Norman Walker of Leeds, an experienced teacher of science to adults, in the

report of the Committee on Science in Adult Education of the British Association:

> The aim of the Adult Biology Class is *not* to produce naturalists—not more than one in twenty average adult students has the makings of a naturalist in him—but to make intelligent citizens capable of a scientific attitude towards public questions and their own personal matters.[6]

It is, of course, impossible to teach methods and attitudes divorced from subject matter and procedures; it is equally futile, as has been pointed out, to expect the teaching of factual content from the various branches of science, or the inculcation of scientific generalizations, to result in scientific outlooks and thinking on the part of the learners. Professor William H. Kilpatrick of Teachers College, Columbia University, speaking of the training of teachers, says:

> Science . . . is a more vital matter of intelligent thinking than most who claim to represent science in education seem to wish or expect; these, in fact, often seem to uphold the idea that the rank and file can use its results without themselves thinking. This . . . is a virtual denial of the essence of science.[7]

The common separation of the objectives of education into information, skills, and attitudes holds for adults as for children and undergraduates; and it holds with special significance for science, in which the information content is constantly changing, and in which skill is a matter of specialization. It is the essential attitudes that come to be of general and lasting value.

The distinction between accepting conclusions of science and appreciating the significance of its methods is illustrated by Professor William L. Bragg of the University of Manchester, in his reply to the criticism that certain of the findings of modern physics are "not new":

> I am sure that when the first circumnavigators of the world returned from their voyage they were told by friends that some Greek philosopher . . . had held that the world was round and that they might have spared their trouble. The world is either round or flat, and endless discussion might have been carried on for ages between opposing schools who held one view or the other. The real contribution to settling the problem was made by the circumnavigators.[8]

The analysis of problems so that the logical requirements of a "proof" can be recognized is an ancient preoccupation of thinking man. The formulation of problems so that recognized issues can be experimentally resolved is a distinct achievement of modern times. From the social point of view, the application of this method to new situations as they arise is a distinct contribution to human welfare. On this point Professors Dewey and Childs write:

> We are in possession of a method of controlled experimental action which waits to be extended from limited and compartmentalized fields of operation and value to the wider social field. In the use of this method there lies the assurance not only of continued planning and inventive discovery, but also of continued reconstruction of experience and of outlook. The expanded and generalized use of this method signifies the possibility of a social order which is continuous by self-repairing, a society which does not wait for periodic breakdowns in order to amend its machinery and which therefore forestalls the breakdowns that are now as much parts of social activity as storms of nature are of the physical order.[9]

The expanded and generalized use of the scientific method and of the experimental attitude awaits a large body of common thinking of which this method and this attitude shall have become integral parts. Instead of waiting for a generation or more to assimilate this, we may hope to accelerate the process through adult education. Moreover, the practical outcomes of extending to social problems the scientific method of attack and scrutiny must be essentially of the kind already attained in lengthening human life and reducing human suffering—matters that had been but a short time ago left to the fates.

CULTURAL ASPECTS

The rapid development of our educational and scientific institutions and, more particularly, the rapid development of specialties in the sciences have resulted in a vast number of highly competent experts in comparatively narrow fields, who are at the same time ignorant of social history and philosophy as well as of the history of their respective specialties. As a

consequence, much of the teaching in special branches of science is carried on in utter isolation from the great stream of thought which constitutes the glory of *Homo sapiens*—undoubtedly an important factor in the mutual misunderstandings, not to say hostilities, between scientists and "humanists." All this, however, is not to belittle the quality of thinking carried on by scientists or the value of their contributions either to science or to society; it is merely to point to a serious gap in our intellectual life.

At the 1927 conference of the British Institute of Adult Education held at Balliol College, Oxford, Professor H. H. Turner concluded his address by saying,

> I venture to think that if a new era is to dawn in the teaching of science, the most helpful avenue is through teaching the history of science. Attention should almost be distracted from the more immediate advances exciting though they may be. It will be impossible, of course, to ignore them altogether, but the fundamental principle should be that of looking backward rather than forward.[10]

The importance of the historical view has been emphasized by many scientists as well as by many humanists. Dr. Charles Singer, the historian of medicine and science, attributes the "current distaste for science" to faulty teaching of history in the schools:

> Starting from the agreed proposition that every adult should know the main results of science he specifies particularly the differences science has made, (*a*) in our way of thinking, and (*b*) in our way of living. These he characterises as the most important events in the history of the last three hundred years. He regards teaching of the nature of these differences or changes as one of the prime duties of a teacher of history, a duty which, in his opinion, the teacher grossly neglects.[11]

From actual experience with adult classes, Mrs. Margaret I. Cole observes,

> The great interest . . . which I found spontaneously arising in this subject has led me to consider whether we could not usefully devote a good deal more time than we do to the study of *the history of scientific thought and its effects.* It is a truism to say that ours is a scientific age; scientific experiment is increasingly at the back of the

economics which we so readily teach in all types of classes, as it is (though less clearly) in the case of the newer kinds of psychology; yet of the way in which science has progressed and the names, even, of those who have furthered its work, very few have any clear idea. . . . Yet, surely, the subject is one both of great importance and great fascination, and, handled by a scientist who combined a knowledge of his subject with a real interest in *its history and influence on the outside world*, could be made of real educational value.[12] (Italics not in original.)

With all this emphasis upon history, it may be well to recall the qualification offered by Professor G. A. Miller of the University of Illinois: "The history of science best suited for the young [let us say beginning] student is that which relates to fundamental questions which are apt to perplex him and not that relating to the preservation of the obsolete from oblivion."[13]

The value of the historical approach in adult education generally, from the point of view of the workers, is stressed by Marius Hansome:

Human Geography, Foreign Languages, History of Science, History of Culture, are subjects which need more intensive and extensive cultivation as background material essential to an intelligent world outlook. The historical treatment and presentation of art, music, and mathematics in the primary and secondary schools would help to build a foundation for a world outlook. In respect of the historical method of teaching, educational research would find "good panning" in the folk high schools of Denmark. The historical approach to various subjects has proved a fruitful means of awakening appreciation of the contributions to culture by foreign peoples.[14]

The task of adult education includes the orientation of men and women in a bewildering world of change for which no amount of scholastic or academic instruction could have prepared them. The meaning of science as a cultural force is to be acquired not from a study of one or several sciences, but from a historical and social survey of the development of scientific thinking and of the effects of scientific thinking. That involves, however, an acquaintance with scientific knowledge and scientific procedures. The problem is one of presenting an integrated picture while instructing in fundamentals and in

elements of knowledge. The task includes finally the development of appreciations as well as of understandings, in a broad humanistic sense, of the achievements of the human spirit in its disinterested search for the realities of the world.

[1] British Association for the Advancement of Science, *Science Teaching in Adult Education*, p. 346.

[2] *Ibid.*, p. 338.

[3] *Ibid.*, p. 346.

[4] *Ibid.*, p. 340.

[5] Benjamin S. Gott, "Science in the Adult Curriculum," an address delivered before the Sixth Annual Conference of the British Institute of Adult Education, September, 1926. In *Science and Adult Education*, British Institute of Adult Education, 1928, pp. 16, 17.

[6] British Association for the Advancement of Science, *op. cit.*, p. 346.

[7] William H. Kilpatrick and others, *The Educational Frontier*, Century, 1933, p. 279.

[8] William L. Bragg, "The Physical Sciences," *Science*, March 16, 1934, pp. 237–240. (Introductory public lecture in chemistry at Cornell University on the George Fisher Baker Foundation.)

[9] William H. Kilpatrick and others, *op. cit.*, p. 69.

[10] H. H. Turner, "Science in the Modern World," In *Science and Adult Education*, *op. cit.*, p. 11.

[11] British Association for the Advancement of Science, *op. cit.*, p. 347.

[12] Margaret I. Cole, "Some Notes in Science and Adult Classes," *Journal of Adult Education (London)*, April, 1930, pp. 207–209.

[13] G. A. Miller, "The Historical Point of View in the Teaching of Science," *Science*, November 28, 1919, pp. 489–493.

[14] Marius Hansome, *World Workers' Educational Movements, Their Social Significance*, Columbia University Press, 1931, p. 507.

PART II

MEANS AND METHODS OF BRINGING SCIENCE TO ADULTS

While every individual gets a substantial part of his education from undirected observation and experience, education in science must, for the lay public, depend upon prior knowledge and thought on the part of others. Dr. John C. Merriam describes the fundamental relationships "among three great phases of intellectual effort," as *production*, *transmission*, and *application* of knowledge. "In research we have the effort to increase information and make it available for the maintenance and enjoyment of life. Application of knowledge concerns phases of human activity ranging from subsistence to the enjoyment of living. Education involves all processes by which knowledge is interpreted or is transmitted from one generation to another or from one group to another" (Thirty-first Conference, Association of American Universities, 1929, page 58).

The *teacher* is the central agency in the kind of educational process that is contemplated in the present discussion.

VIII
THE TEACHER

PERHAPS the most significant factor limiting the amount and character of science teaching to adults is the supply of suitable teachers. Those charged with administering education for adults seem forced to choose between teachers who are more or less qualified to deal with one or several branches of science, and scientists who are more or less competent to teach.

QUALIFICATION OF SCIENCE TEACHERS FOR ADULTS

The requirements of science teachers have been variously formulated. They include, in addition to a mastery of subject matter, which should be taken for granted (but cannot always be), such elements as enthusiasm for the subject; personality; teaching skill; imagination; high standing to attract the public; broad human interests; wide human contacts in the world of affairs; human sympathy that enables the specialist to see what there is about his work that would interest the layman; ability to appreciate the questions and point of view of the students; ability to arouse interest in natural science as a study of the conditions of human action. No doubt others could be added.

The general agreement seems to be that the teacher of science must be more than a purveyor of information or facts or rules. There is required the ability to speak accurately and yet simply, "in everyday language."* His "business is not so much to instill facts as to cultivate an attitude of mind." He should be of "the general practitioner type rather than the highly specialized."

* See pp. 79 and 80.

From the specifications enumerated it would seem that the ideal teacher does not exist, for if we combine the best features of each formulation we shall set up criteria that cannot be met. Or if the ideal teacher does exist, he is probably too much absorbed in some other work to be diverted into leading lay men and women into the scientific world.

SCIENTIST AS TEACHER

The availability of scientists as teachers involves, as the committee of the British Association points out, questions of career and finance. The individual has to meet the conflict between getting current funds and devoting himself to research, upon which his future depends.[1] But the question involves the further conflict between expert performers in the classroom or on the lecture platform, who successfully transmit what they have acquired, and the continuous growth of the investigator, who transmits the spirit of science because he is continuously imbued with that spirit as a creative force in his own life.

There is a sharp difference of opinion as to whether research workers should be encouraged to make the effort to "popularize" the results of their investigations. "The scientists themselves are not necessarily well suited to the diffusion of appreciations and understandings. Compare music critics and teachers with creative musicians." "The laboratory scientist cannot, and should not waste time in an attempt to popularize; and usually he is less fitted to write for the public."

In contrast to this is the experience of a distinguished scientist, as described by himself:

> Years ago I assumed that the scientist who could do research work which other people could not do . . . should stick to his job and not bother with the man on the street. I believed that various skilful writers could get over to the public the germ of the scientific ideas better than the scientist could. . . . Later I thought that all the scientist has to do is simply to take an hour or two off and dash off an article which will meet the situation perfectly. . . . The next step was the realization that the diffusion of learning is a thing that is necessary, . . . a serious thing. It is an obligation on the part of the scientist not simply to keep his information in the cloistered

laboratory or in a highly technical journal; but he is the one man of all men who can present it and bring out its salient points for the public, *provided he will take the time.* . . . So I took the time, and frankly it takes a great deal of time, as of course a good thing should . . . today I consider it a part of my function to *take the time* to prepare carefully these statements and reports. It does . . . break into other scientific research work. Still, on the basis that the business man states that if you want anything done ask the busiest man to do it, I can not say I have seriously hampered research work by such procedure.

And another distinguished scientist, who is exceptionally well situated to judge, says that this man has become "one of the most effective writers to the public" in his group, and that "it has been worth the effort."

For the individual scientist it is a matter of disposition as well as of time. If it is true that the amount of creative work which one may turn out is limited by factors other than time, the use which the scientist makes of his marginal hours must be left to his own discretion. If he prefers to write for the public or to lecture, that is well; but if he prefers to paint or to go fishing or to write Latin verse, that is well too. There are, however, legitimate claims which the public can make upon the scientists, collectively and individually, with respect to their educational function.

As a group, scientists have done much to further the extension of science teaching in the schools; but that is not sufficient. In his address at Boston in December, 1933, Professor John Dewey said,

The obligations incumbent upon science can not be met until its representatives cease to be contented with having a multiplicity of courses in various sciences represented in the schools, and devote even more energy than was spent in getting a place for science in the curriculum, to seeing to it *that the sciences which are taught are themselves more concerned about creating a certain mental attitude than they are about purveying a fixed body of information or about preparing a small number of persons for the further specialized pursuit of some particular science.*[2] (Italics not in original.)

While any individual scientist may take no active part in educational work, it is especially important in adult education

that every individual scientist contribute toward "influencing the much larger number to adopt in the very make-up of their minds those attitudes of open-mindedness, intellectual integrity, observation and interest in testing their opinion and beliefs that are characteristic of the scientific attitude."[3]

Every contact between a layman and a specialized professional worker is an occasion for educational influence, whether consciously so used or not. The scientist may not be able to elucidate his thoughts in words of one syllable, but he is able to manifest a secretive or a candid attitude toward the layman; he is able to imply the mastery of unspeakable mysteries to inspire the other with awe, or he may reveal his own awe before the vast unknown which he daily confronts. He may speak of what he does know as if it were the private treasure of the privileged, or he may speak of it as that common inheritance of the race of which he happens at the moment to be one of the custodians.

Scientists cannot claim credit for the beneficent uses to which their thoughts and findings are put, just as they cannot be held liable for the destructive and injurious applications made of their thought and findings. If scientific research is to continue effectively, if science is to retain its virtue as well as its opportunity as part of our civilization, it is the scientists who must guard their thoughts and their findings against exploitation, whether for private purposes or for governmental purposes. This they cannot do by directing what use may or may not be made of science; that is out of the question.* They can protect

* The desire of scientists to protect against private exploitation the public's interest in scientific discoveries has in recent years taken the form of obtaining patents on behalf of universities or other public agencies. Many important inventions as well as discoveries have been made possible by the gathering of information, the making of surveys, the conduct of experiments, through public agencies, and it is felt that the usable end product is rightfully the public's. A special difficulty has appeared in deciding what to do about important discoveries that have a direct bearing upon health or therapeutics. Such inventions need not be patented; but unless they are patented there is no assurance that they will be used at all, or without injury to the public. The tendency among more progressive institutions is to arrange for patents which are then dedicated to the

science only by consistently furthering through their demeanor and conduct the tentative and undogmatic attitude with respect to "beliefs" which gives science both its worth and its capacity for growth. And that is education—adult education. More directly, they can further science by cultivating among their colleagues and associates an appreciation of this public obligation, which will thus advance adult education in science more helpfully than additional hours of popular lectures in geology or botany.

The obligation of the scientists to the public rests directly upon the support and interest of the public. Without prejudice of a militaristic or pacifistic sort, we may say that the public which supports the army so that it may carry on as effectively and as comfortably as circumstances permit wants also to know what all the shooting is about; and so far as circumstances permit and so far as the public can understand, it is entitled to know what is happening in the war, day by day.

TEACHER AS SCIENTIST

The obverse of the problem of using the scientist as teacher is found in considering the teacher's relation to research. The growth of the teacher at every level depends upon vital and continuous traffic with the processes of scholarship and research. The college and the university must not merely acknowledge the value of the teacher by granting fuller recognition and opportunity to those who can teach and like to teach; they must eventually expect of all teachers as a matter of course an active participation in the current thinking and investigating. It would therefore be desirable to conceive of "adult education" as being quite as much the concern and need of those engaged in the educational business as it is of the hypo-

public. Several "university foundations" have heen formed to protect inventions and discoveries against private encroachment, by means of patents. A committee of the American Association for the Advancement of Science has issued a report on "The Protection by Patents of Scientific Discoveries," which discusses various phases of this problem (*A.A.A.S. Occasional Publications*, No. 1).

thetical "lay public" which these educators presume to serve. To be an acceptable teacher one must be a constant learner.

[1] British Association for the Advancement of Science, *Science Teaching in Adult Education*, 1933, p. 343.

[2] John Dewey, "The Supreme Intellectual Obligation," *Science*, March 16, 1934, pp. 241–242.

[3] *Ibid.*, p. 242.

IX
THE SPOKEN WORD

LANGUAGE is basic in human thinking as well as in communication; and communication is a very large part of educational effort. There can indeed be no educating without language; and yet language not only evolves its own obstacles to mutual understanding but is always in danger of evaporating into empty words. The business of teaching too, whether casual and incidental as in the living together of older and younger, or more systematic and deliberate as in the relations of teacher and learner, rests on telling—uttering the appropriate word.

The growth of science involves a progressive elaboration of a special language. The scientist (1) invents new terms and (2) arbitrarily restricts the meanings of familiar terms.

The first is irritating to the layman. It frustrates him, obstructs his approach to the desired knowledge or understanding; it tends to make the speech of scientists esoteric. The layman indeed often suspects that the introduction of new and strange terms is a manifestation of pedantry and exclusiveness; that the scientist could just as well use "plain language."

The second is a source of confusion, since it is impossible, through the simple expedient of "defining" terms at the beginning of a lecture or treatise, to wipe out the multitude of divergent—and often conflicting—connotations and emotional accompaniments that the familiar terms of any language have acquired.

Both of these linguistic processes are, nevertheless, essential to clear thinking at any level. The introduction of technical terms is not confined to technical science. It is the routine

procedure in every field of human activity in which communication and precision are required, in sports and commerce no less than in electrotechnics and metaphysics.

It is futile to undertake to learn—or to teach—science in "everyday language"; there is in fact a serious danger in doing so, the danger of complete misconception. The nearest approach to this is the *translation* of the thoughts of science by means of everyday language. But this translation must be carried on by men and women who realize that they are doing something analogous to translating or interpreting poetry, not merely restating phrases and sentences into the nearest verbal equivalents from the vernacular.

In contrast to the systematic and progressive development of vocabulary and concepts in school, adult education must generally deal with wide variations of background and experience and comprehension. The instructor must come into more intimate touch with the minds of those he is guiding. Hence the "discussion" method or less formal conference is better suited for adult education than the systematic lecture. Science cannot, of course, be discussed by groups as if it required merely an exchange of opinions or a search for agreement. The purpose of the discussion is to clarify, to cultivate critical analysis, to bring about a meeting of minds in terms of the scientific concepts and procedures, not of acceptable beliefs.

Another consideration raised by the transmission of science through the medium of spoken or written words is the fact that people can, and do, use words for many other purposes besides transmitting information, explaining, clarifying, stimulating thought. Words lend themselves to misleading and browbeating, for example, to propaganda, to emotional arousing, to deliberate deceit. The question has been repeatedly raised whether educators could not profitably take over the techniques of oratory and advertising, for carrying on their work. This question points to a basic need for clarifying the purposes of education, especially of scientific education. There seems to be an irreconcilable conflict of purposes between

science education and advertising, for example, or between science education and the preaching of a gospel. In one case the purpose is to gain assent, to impose a belief or an action; in the other case the purpose is to cultivate critical analysis, to stimulate the search for validity or reliability of affirmations.

Finally, words are limited in their effectiveness: they have to be supplemented with tones and gestures, with punctuation marks and other symbols. Whether spoken or written, they come to call for further supplements in the way of pictures and diagrams, things and models, action, demonstration. And the learning must be more than a passive reception and remembering of the words, of the things and figures seen and heard. The psychologist calls for "self-activity" as a condition of learning. An earnest discussion may well be the beginning of such self-activity, leading eventually to more active participation in the processes that give science reliability and validity and value.

LECTURES

Lectures constitute the traditional form of "adult education" and seem still to have value today, and in the field of science as in other fields. The single lecture and the course of lectures can serve effectively at a relatively low cost.

Some of the most valuable courses of lectures are offered to the lay public by institutions of higher learning and by professional organizations. Outstanding examples are the Lowell Lectures at Harvard; the Massachusetts Institute of Technology lectures given Fridays and Saturdays; the New York Electrical Society lectures; the Lane Memorial Lectures to the public in San Francisco, and the Harvard Medical School Sunday Afternoon Lectures to the public. A noteworthy example of excellent educational lectures in science by a commercial agency is seen in the occasional offerings of the General Electric Company. In all of these lectures, equipment for demonstration is at hand. Their popularity indicates their effectiveness in reaching people, but they are also of high merit educationally.

Similar in many respects are the lectures offered by various museums, botanical gardens, local academies of science, and analogous organizations.

While the extension of the lecture to reach more who would be interested and helped is naturally restricted by the availability of suitable rooms and equipment, the chief obstacle is a lack of initiative and organization. There are hundreds of high schools throughout the country that have scientific equipment that lies idle a large part of the time; and they have suitable auditoriums or lecture rooms that are admirably suited for scientific lectures and demonstrations. It is only rarely, however, that the school people are concerned with extending the educational facilities to the adults of the community, except in terms of helping the illiterate or otherwise handicapped. There seems to be no general assumption that continuous educational activity is a normal part of present-day life for adults, including teachers.

There is reason to believe that in thousands of towns any lay group which undertook to organize the community's resources and interests into an educational program for adults would meet with immediate response; and that a program in "science" would be successful about in proportion to the effectiveness of the instructors.

UNIVERSITY EXTENSION LECTURE COURSES

University extension classes in the natural sciences seem often to be unsatisfactory or excluded because of the lack of suitably equipped laboratories. A director of extension in one of the universities writes that "even in regular schools, too much of the teaching comes to be a matter of discussing or verbalizing . . . teachers who know the difference between formal or academic instruction and the development of understanding among adults seemed to be lacking." This judgment as to the limitation of university extension lectures is confirmed by other observations. There are probably many men and women who would attend lectures in which the leader made

an attempt to clarify new ideas in science, but who will keep away from courses that attach importance to the systematic exploration of a "subject" along academic lines. One of the things we need very much to find out is whether the purposes of adult education in science are better served with or without the effort to "maintain standards" that warrant the granting of "credits" or certificates parallel to those of colleges or high schools. We shall probably find that there are many needs for many different kinds of people, and that, while facilities are probably adequate for those seeking credits and degrees, other groups are not so well served.

THE RADIO

Although the radio is a very recent technical development and one that is usable only through very elaborate and very complex and very expensive organizations of equipment and personnel, it operates educationally in terms of the most direct and most primitive efforts to transmit ideas—namely, the spoken word.

In so far as the problem of education is one of sending forth the spoken word to deliver its message, the use of the radio has many advantages over the lecture or the classroom address. There is the obvious economy. Professor Harlow Shapley of Harvard University says, "Use the radio and speak to thousands, instead of taking valuable time with a class of twenty or thirty, or even a lecture for several hundred."[1] And the thousands, scattered over a wide area, cannot otherwise be brought together for a common pursuit. Moreover, the radio can reach the thousands who cannot read, or who read only with difficulty.

The matter is not so simple, however. The radio offers the voice only, with its inflections, to be sure, its pauses, its shadings; but without facial expression, without gestures, and, what is for science especially important, without any visual aids, not even the movements of the speaker's lips. The radio

audience is, so far as the speaker is concerned, virtually blind. This at once limits the radio in science to certain functions.

The radio can serve to make sharp announcements and to arouse interest. In fifteen minutes it is possible (for the competent speaker) to introduce a situation, to state a problem, to indicate lines of exploration, findings, interpretations, and to suggest further possibilities, further reading perhaps. The radio can serve to interpret anew material that is more or less familiar, to discuss the inadequacies perhaps of current beliefs, or to make clear the difficulties in the way of a simple explanation. The radio can dramatize important discoveries or ideas, it can picture personalities that have contributed to science, it can glorify scientific achievement and develop appreciations.

Science Broadcasts

Science Service has been broadcasting a fifteen-minute talk on some science topic weekly since 1924, with the cooperation of some of the country's leading scientists, over the Columbia network. The company's own description of this series indicates a desire on the part of the broadcasting company to make the educational features included in their programs a genuine service:

> Commentators on American life have frequently pointed out that one of the most interesting aspects of our public consciousness is to be found in the ignorance or indifference of the average American citizen toward scientific achievements whose benefits he accepts but whose mysteries he fails to comprehend. If this series of Science Service programs, in its nature, conceded this lack of public knowledge on scientific subjects, the nation-wide response which it engendered refutes the charge of public apathy. Educators have considered it one of the most outstanding contributions to adult education which radio broadcasting has offered.[2]

The radio has been successfully used in broadcasting short talks and series on various phases of nature study, astronomy, history of medicine, exploration, archaeology, geology, biology, and so on. The University of Michigan Broadcasting Service

has been including from 20 to 35 per cent of science topics in the general series supplied by the faculties of the College of Literature, Science, and the Arts. In addition there were series from other special faculties (engineering, law, medicine, etc.) so that the broadcasting time given to scientific subjects came to from 13 to 45 per cent of the total. Other state universities have been developing radio programs; and science finds its place to a varying degree in all of them.

In a study of the radio as used by the land-grant colleges, twenty-nine of the thirty institutions that furnished analyses of their programs reported the use of natural-science subjects.[3] This study also warns against assuming that the radio can replace other forms of educational endeavor; it will only "make it possible to widen the service, to study groups, potential users of the library," and so on, by various other agencies.[4] Emphasis is laid on the importance of planning programs for special homogeneous groups, while other programs are planned for the general public.[5]

Systematic Instruction

There is as yet no agreement as to whether the radio can be effectively and economically used for systematic instruction. The Joint Radio Survey Committee concludes that "the broadcasts should not be in the form of systematic courses of instruction to the general public, but should consist of general information broadcasts. Part of these broadcasts should be planned to reach the general public and part to meet the needs of specific groups."[6]

The advantage of reaching large numbers over a large area by means of the radio is to a degree offset in the natural-science field by the natural differences in the concrete environment. Systematic instruction that presupposes direct acquaintance with particular flora or fauna, with particular types of minerals or land formations, must be confined to local stations. Extensive science broadcasts must be of a generalized character or deal with materials generally accessible.

In the series of educational broadcasts conducted by the National Advisory Council on Radio in Education in 1931–1932 there were several courses in science (for example, "Psychology Today," "Animal Behavior," "Child Development"). These broadcasts were, however, carried on under special experimental conditions and were supplemented with prepared material in the form of "Listener's Notebooks," containing outlines, illustrations, suggestions for further reading, and other aids. The results of these experiments should indicate possibilities worth cultivating as well as further lines of investigation.

Supplementary Aids

Various museums and academies of science have also conducted broadcasting programs in the sciences. It has not been possible to obtain information on which to base recommendations with any confidence. There are experiences, however, which suggest ways of combining the radio with other instrumentalities. In Rochester, New York, and in Cleveland, broadcasting of science lessons for the schools under conditions that combined the talents and other resources of a central school agency with the efforts of the classroom teachers yielded results that would warrant experiments in broadcasting for adults in specially prepared centers. We can hardly hope to repeat in science the successful group work done with the radio in subjects that call for no more than listening and discussing.

One way of reenforcing the radio as a teaching instrument has been tried out in other fields. Lessons in cooking or in toy-making, for example, have been broadcast to interested listeners who are presumed to have before them the materials with which to operate under the direction of the voice coming from the loud-speaker.

In connection with the programs of forthcoming broadcasts, it should be possible to print various aids similar to those contained in the "Listener's Notebooks" already described above. The Buffalo *Courier-Express* has been devoting one

page of the rotogravure section each Sunday to pictures supplied in rotation by three museums, including the Buffalo Museum of Science; and these pictures have been tied up with radio talks on the same evenings, from a local station. Full announcements are carried by the newspapers as well as by the museum bulletins.

The great difficulty here would seem to be that of getting either the wholehearted cooperation of the newspapers or sufficient financial support to insure systematic publication of the requisite material, announcing at advertising rates when necessary. The present rivalry between the radio and the newspaper as advertising media makes cooperation on educational grounds difficult if not impossible. A satisfactory technique for combining the printed page with the radio needs, however, first to be worked out. The development of broadcasting in England suggests that eventually reliance may have to be placed upon separate bulletins, guides, leaflets, and so on, rather than upon the newspapers.

Control

In the study of radio broadcasting in land-grant colleges and universities already referred to, over 86 per cent of the educators and administrators favored ownership of the station by the institution or by the state, although nearly two-thirds of them approved the use of a commercial station "if the time is full, uncensored, and guaranteed as to its permanence." Lack of funds was given by 84 per cent of some 360 persons interviewed as the principal reason for not operating broadcasting stations in their institutions. Reliance upon the sale of advertising for the support of educational broadcasting is distinctly disapproved by educators as unsound public policy.[7]

This is an important problem that applies perhaps equally in all fields of education by radio. Its special significance in relation to science lies in the fact that much of the special pleading and advertising on the radio is in flat contradiction of the methods

and findings of science. The extravagant claims for cosmetics and cigarettes as they come over the radio are, on the one hand, more effective than similar claims in the newspapers and, on the other hand, more dangerous because less easily checked by the listeners. But neither the broadcasting company nor the sponsors would think of "censoring" the speaker's teachings, although the company does assume the responsibility of protecting the public against a noted pediatrician's using the *word* "nipple" in a talk on the bottle-fed baby! As in the case of the newspapers, the teaching of science that might conceivably protect the consumer against misrepresentation by advertisers is not to be demanded of those who profit from the sale of advertising.

The educational administrators who value public or institutional control of educational broadcasting seem to be generally aware of an inherent conflict between the educational purpose of the college or university and the private interests of the advertiser, or between the scientific purposes of the educator and the partisan or sectarian interests of the public official or propagandist. Even those who favor the sale of broadcasting time, or the acceptance of contributions, by college stations, warn against donations "for self-advertising or propaganda purposes." Or they assert that "educational service should have no commercial flavor," or that "advertising must have the same standards and controls as the *Journal of the American Medical Association* applies in accepting advertising."[8] Broadcasting involves the same problems for both the public and the advertisers as are found in press publication, but also special difficulties in regulation.

The criticism of advertising from many different sources, accompanied by attempts to regulate advertising more rigorously through governmental agencies, has in recent years brought from the advertisers themselves, first, a general alarm calling upon the public to protect its sacred right of free speech against the threats of the government or the censor; second, a general denial that there was anything false or misleading in

their public claims; and, finally, a righteous reaffirmation of their loyalty to truth.

Conflicting Interests

The Federal Trade Commission, which is authorized to regulate (chiefly through injunctions) objectionable advertising, found that, of 146,117 advertising continuities submitted for broadcasting during the summer of 1934, 125,126 were unobjectionable, leaving some 21,000 for further checking and investigation—that is, 85.6 per cent of the run of broadcast advertising in July, 1934, was unobjectionable. This confirms the broad doctrine that no class of our citizens may be indicted as a whole for the shortcomings of a small fraction; but it does not dispose of the need for regulation. From the point of view of the public there is great need of protection through access to scientific knowledge and interpretation.

The Federal Trade Commission is authorized to protect interstate commerce against "unfair competition." The misrepresentation of merchandise through false or misleading advertising seems to be made unlawful, not because it might injure the purchaser, but because it gives the advertiser an advantage against his competitors. It is assumed, of course, that the claims of an advertisement may be properly checked by an expert assay of the merchandise in terms of chemical or physiological action; but the grievance against false advertising remains that of the competitor, not that of the consumer. If all the members of an industry agree on the consistent use of "trade names" that mislead the public, it is questionable whether the commission could assume jurisdiction except on the complaint of a rebellious member of the group.

In general it seems probable that the educators interested in broadcasting would demand a quality and a degree of "truth" in advertising that are not in all respects identical with the meaning of "truth" to the advertisers. In matters affecting patent or proprietary medicines, health "systems" and appliances, food preparations, cosmetics, and related classes of

goods and services, neither the public nor the directors of radio stations can check or censor what the advertiser offers to put on; and any attempt by educators to scrutinize, criticise, or contradict the advertising in the name of "science" can be disposed of as an interference with business, which, if we accept the Federal Trade Commission's sampling as representative, is, after all, over 85 per cent reliable, or at least unobjectionable.

The close identification of the broadcasting companies with advertising as the sole source of revenue involves another element that is important in science teaching. As pointed out by Dr. Clark,

> Everything that can possibly be interpreted as advertising in any form must be eliminated from all radio talks. This includes mention of books, magazines, newspapers, merchandise of all kinds, transportation agencies, steamers, hotels, institutions supported by private donations or public funds, etc. Great care must be taken to see that this rule is rigidly upheld and inflexibly applied to every talk. The unintentional inclusion of some form of advertising is perhaps the most frequent sin committed by writers of radio talks.[9]

The same rule holds in the writing of textbooks, although for different reasons. In any case it imposes upon the broadcaster in science limitations which every teacher will appreciate. He must not mention a book or a particular appliance gratuitously. Information about chemicals which the ordinary consumer can obtain conveniently only under the trade names of special preparations will have to be withheld or hidden under the correct but useless technical name.

The progress of science depends upon the freedom to teach as well as the freedom to inquire; and if the radio is to become an effective instrument in the extension of scientific knowledge and understanding among the public at large, it will have to acquire a degree of freedom apparently not readily attainable except through broadcasting facilities directly responsible to the public. It should not be necessary to choose between commercial and political censorships.

[1] Conference, April 9, 1934.

[2] National Association of Broadcasters, *Broadcasting in the United States*, Washington, 1933, p. 36, note.

[3] Joint Radio Survey Committee, *An Appraisal of Radio Broadcasting in the Land-Grant Colleges and State Universities*, National Committee on Radio in Education, Washington, 1933, p. 47.

[4] *Ibid.*, p. 98.

[5] *Ibid.*, p. 60.

[6] *Ibid.*, p. 98.

[7] *Ibid.*, pp. 76–84; 99

[8] *Ibid.*, pp. 74, 75, 76.

[9] Austin H. Clark, "Radio Talks," *Scientific Monthly*, October, 1932, p. 357.

X

THE PRINTING PRESS

THE invention of printing in Europe at once aroused in men of imagination the hope that the good word, wherever spoken, would be quickly and suitably embodied in books and made permanently available for the enlightenment of everybody everywhere. This hope has been disappointed. There is still much illiteracy even among advanced peoples. Many of those who can read do not read enough or reflectively or with discrimination.

The machine which makes so much possible is not itself discriminating: paper is patient and the press will promulgate whatever is fed to it. We are finding too that the good word is not necessarily good for everybody or forever. And while many deep thoughts cannot get themselves printed, there is a monstrous mountain of pulp daily converted into reading matter that is obsolete and without meaning almost as soon as it appears before the eyes.

From the first, too much weight was attached to the recorded word. "One obstacle," wrote Dr. Slosson, "in the way of spreading science, that is of inculcating the scientific habit of mind, is that people have learned to read too well. Books may become an impediment to learning. Our students are taught how to learn to read but not always how to read to learn.[1] For while the press lends itself readily enough to the recording and dissemination of scientific knowledge and ideas, to the recording and perpetuation of the million facts and findings that constitute the raw material of science, it carries also a spirit of dogmatism. To this very day masses of readers accept the mere printing of a word as the warrant of its authenticity;

and they are distressingly confused because contradictory words confront them in print.

On the other hand, as people become more sophisticated, credulity is naturally overcome. But, unfortunately, credulity is commonly displaced not by criticism but by a cynical skepticism: "You cannot believe anything you read." This condition has been brought about chiefly by the newspapers, which are not only the most immediate sources of information and thought for practically all adults who read at all, but almost the only sources for large masses. Whatever science the daily press teaches, therefore, is likely to be for those large numbers the only science they get.

NEWSPAPERS

As has been pointed out, the dissemination of science as "news" has been for years on the increase (see also page 135). There are now between twenty and thirty full-time "science editors" working on the newspapers. In the fall of 1934 there was formed the National Association of Science Writers.

The quality of the material has also improved, both from the point of view of its reliability and from that of its literary merit, although there is still a great deal of rather crude "nature" lore and of misleading exploitation of the "wonders" of science. These qualitative gains have come very largely through the influence of Science Service, the Associated Press, and the press service of the American Association for the Advancement of Science. The first of these was chiefly responsible for "selling" science to the newspaper editors, who have in turn molded the material into forms congenial to journalism. The last similarly "sold" publicity to the scientists, whose cooperation is essential if authentic information is to be made available to the public.

There is still among many scientists considerable suspicion of, not to say hostility to, the newspapers, a relic of the time when the journalist could find in science and scientists nothing but the ridiculous or a ready supply of the sensational. The tradi-

tion of the journalist yields the merit of readability, graphic and colorful presentation, quick transmission of ideas. These are all gains in contrast to the dry and often pedantic writings of the specialist, which are not in any case readily available to the general public. The defects of the journalist's virtues appear in a tendency to sensationalize, to out-shout the orchestra, to misplace stress, and, on occasion, to discolor and even to censor the science news.

The traditions and the changes which have come about are both well expressed by Dr. Francis G. Benedict, director of the Carnegie Nutrition Laboratory in Boston:

> For a long time I was a bitter enemy of the press with regard to disseminating scientific knowledge. My own personal experience was . . . that the newspaper man was not after the truth but after a sensation. . . . In the last twenty-five years this attitude has changed materially and I do think that certainly the great metropolitan papers and . . . [probably also] the country papers, are distinctly out to get a true statement of facts. They will color it, naturally. At times they will put on a color that should be on, and make an otherwise colorless and flat statement one that challenges attention, and of course only too frequently they will destroy by color and completely mask the crucial point. Still, I do think that our press, not only Science Service but even A. P. and the other agencies, do want reliable stuff. It is up to the scientist to see that they get it.

We may find some encouragement in the observation of a leader in the field of newspaper science that the German and French papers frequently print well written and intelligible *feuilletons* by distinguished scientists.

While there has been great improvement, the disposition among the journalists in general is still to draw upon the sensational or exciting. The news story has to be something sharp and distinct: the press, from its very nature as a communicator of "news," must be positive and definite in its presentation. The scientist, on the contrary, hesitates to commit himself to positive assertions which may later have to be withdrawn or radically modified. The unqualified assertions of the reporter sound to the scientist too much like final doc-

Facts and Meanings

One of the basic difficulties in the use of the newspaper as a medium for education in science lies in the editorial assumption that the paper presents "only the facts." The journalist prides himself on making an unbiased record of events; yet it is in practice impossible to get by means of the reporter's story a verbal equivalent of the camera's pictures. As Dr. Whitehead writes, "Theories are built upon facts; and conversely, the reports upon facts are shot through and through with theoretical interpretations." Events, he says, cannot be described as "bare facts." The historical criticism of contemporary observations which purport to record bare facts is that they are always provincial and shortsighted. "Knowledge is always accompanied with accessories of emotion and purpose."[2]

The popularization of science at any rate calls for more than a restatement in popular terminology of what the scientist saw or heard or said. Frequently the scientist himself does not know the meaning of what he has done, although he feels that he has something of interest or significance to his colleagues, perhaps to "science" in general, or to the public. In such circumstances it sometimes happens that an interview with a skilled journalist helps him to clarify or define his own position. The discoveries, as they come from the laboratory or observatory, the answers which he has found to his own questions, are usually fragmentary, partial. It is difficult to tell how far the immediate findings have brought the investigator toward his goal or toward solving a broader problem in which the lay public is interested.

The need to simplify and the desire to be perfectly objective result in making much of the material as it is offered to the public extremely trivial, or at all events without any indication as to its significance, either as related to the underlying problems and historical developments or as related to the interpretation of conditions and phenomena. If science, as a mode of dealing with problems, is to be effectively assimilated by the public,

it would seem to be necessary to supplement the journalistic function of the newspapers with forms of comment that will bring out the cultural and philosophical implications of the "news," as distinguished from the economic or technical applications.

The science writers, as they bring more and more of the partial and unfinished science discoveries to the surface, find it too difficult to make these items interesting without implying positive achievement, whether in solving theoretical problems or in yielding practical outcomes, far beyond any warrant. Very often it becomes necessary to supply considerable background material to make these fragments have either meaning or interest.

News and Interpretation

The editorial elaboration of news as transmitted is actually a part of modern journalism, in many fields other than science. Political news is constantly presented in relation to current developments, to the purposes of leaders or of governments, to the hopes or apprehensions of one or another group, and to the pending decisions or outcomes of important events. Background material is even more important in connection with science news than with most political and topical news; yet it is more difficult to supply it because neither the staff writers nor the reporters are often equipped to prepare it hurriedly, even if the facilities were at hand—as they no doubt are in the libraries of the larger newspapers. The disposition of most journalists to rely upon the "morgue" often brings forth "human-interest" trivialities to the neglect of significant background facts and ideas.

The Chicago stockyard fire was reported in all the Sunday newspapers the following day along with supplementary information on the great Chicago fire of 1871 supplied by the Associated Press. Similar supplementary material is often furnished on the occasion of some spectacular natural occurrence, such as a volcanic eruption or a tidal wave; or on the

occasion of some important catastrophe, such as the sinking of a boat, a forest fire, and so on. Obituary notices are supplemented with biographical sketches varying from a few lines to a few columns or more. And certain bits of news are elaborated into editorial interpretations—commonly designed, to be sure, to guide public opinion in the right direction, but often disinterestedly written to further public understanding.

Increasingly, too, books are becoming items of news interest and are being introduced to the public by newspapers through critical reviews by competent and responsible writers who describe and analyze and interpret without any regard whatever to the political bias or social policy of the editors and publishers.

For the discussion of scientific news in the newspapers these developments furnish favorable precedents. Even the interpretation of science in a manner that discredits the claims of advertising becomes possible, at least in some of the more progressive journals, just as the adverse criticism of advertised books has become possible.

The reporter has to bring back a story. As an intermediary between the scientist and the public he then has the task of *translating* scientific language into "journalese." This translating, as pointed out above, involves more than restating in more familiar terms. The skillful writer reports sports and financial news without having to translate, simply because he is using a common language—that is, a language common to himself and to his readers, on the one hand, and to the technicians, on the other. Even the specialized meanings in which the common terms are used are already familiar. This becomes obvious to anyone who reads a newspaper account of some game that he does not understand or of some market manipulations that are beyond his horizon.

Selection

From an educational point of view, the journalistic handling of science news meets another difficulty in the matter of selec-

tion. On the one hand, the organization of our institutions and professional groups is such that the flow of scientific information which might be made available to the public is very uneven. "There is a high flood at the time of the 'convocation week' meetings of the American Association for the Advancement of Science, and then long relatively arid intervals." If the output of these meetings is not used promptly it soon ceases to be "news." On the other hand, Science Service finds that at all times of the year there is more science news than can possibly be used. It is obviously impossible to regularize the flow of information. The great need is to take the most interesting items, as judged by the journalist, and the most important items, as judged by the scientist, and present them most significantly, as judged from the educational point of view.

There would seem to be enough "new" material *each day* to satisfy a wide range of interests and tastes; but it is probable that the emphasis on the news value is in most cases meretricious. To quote Dr. Slosson again,

> One of the surprising facts that we have found out in the efforts of Science Service to aid the popular press in keeping up with scientific progress is that the hardest thing to sell to a newspaper is news. Old ideas go best, if dressed in slightly novel guise, just as an old joke is surest to win a laugh from a crowd. The facts and theories now being brought out in many of the sciences are so novel and revolutionary that they are instinctively rejected by the lay mind as inadmissible. This is not because they are incomprehensible but simply because they are unfamiliar. I have often tried to get over a strange idea by building up a gradual ramp from common ground to the point where it is an easy step to the new notion but the editor is apt to cut off the very point which the article was written to convey, leaving only the conventional and commonplace material used as an approach to the novel information.[3]

Another indication of the relatively minor role of "novelty" in making science items interesting or available is seen in the frequent reprinting of a good story from one newspaper to another, until it finally gets back, somewhat altered, perhaps, or even unrecognizable, to the old home from which it set out

years before. Frequently, too, the newspapers discover something sensational enough to warrant a large headline or a conspicuous position, but old enough to arouse the disgust of the scientist who happens to be acquainted in the field.

It took the newspapers fourteen years to discover the special theory of relativity, and they discovered it then only because a first-rate mathematician, Dr. Carr Van Anda, happened to be also on the staff of the *New York Times*. To a considerable degree the present-day practices and the current journalistic techniques tend to meet both criticisms, that is, as to selection for news value and for importance.

Another phase of the newspaper's problem of selection may be considered as essentially sectarian, or at any rate doctrinaire to the extent of presupposing knowledge as to what the public wants or will accept. An example of this is the ambiguous policy of most American newspapers with regard to the treatment of biological subjects that approach a scientific consideration of various aspects of sex, in contrast to the irresponsible exploitation of the salacious in the form of sex scandals or of "comic strips." We may cheerfully admit that we do not know what the public wants, but without conceding that the editor does know. The *Christian Science Monitor*, with a circulation of 125,000, is the largest and probably the typical representative of a small group of sectarian newspapers that restrict news of crime and disaster to what is "sufficient for information but without unnecessary embellishment or sensational display." This policy is understandable as an expression of the desire to emphasize "the best developments in human life . . . from a moral and spiritual viewpoint." Accordingly these papers bring science news (which as a rule is scrupulously accurate) as it touches the majesty of the heavens and the mysteries of the atom and the beauty of the flower but avoids all reference to bacteriological or physiological findings, to the diagnostic or clinical use of the X rays, or to phases of synthetic chemistry that might suggest pharmaceuticals. It should be emphasized, however, that these

papers exclude with like consistency all advertisements for cancer cures or blood purifiers.

Needs and Possibilities

Because of the strategic position occupied by the newspapers it will become increasingly important to use them for broad educational ends, as distinguished, on the one hand, from the dissemination of "news" and of more or less useful information on various practical things and as distinguished, on the other hand, from propaganda calculated to regiment opinion into partisan or sectarian convictions and complacencies and hostilities. If the benefits inherent in science are to be retained, the social and human need for spiritual integration will not be served by insistence upon the true faith, the chosen people, the favored nation, the "loyal" party, the sound doctrine. This great need will be served by diffusing the spirit of science, with its open-minded readiness to attend to all voices, and its critical suspicion of its own convictions.

Among the suggestions received is the recommendation that science news stories include references to books for further information. This would involve really insuperable difficulties, even if the publishers and editors were ready to waive the objection that such references would constitute "free advertising." A more urgent need is that for improving the headlines of science stories. In the smaller cities headlines are prepared by copyreaders, who work under great pressure, but on the larger papers skilled headline specialists are employed. The results in either case sometimes embarrass the science reporter who has had to overcome the resistance of the scientist to get his material.

With all its defects, newspaper science is apparently meeting a real demand and rendering a useful service. Improvements must await at least in part the further education (chiefly through other agencies) of a public to demand and appreciate more substance and more illumination in its science news.

MAGAZINES

Magazines occupy a position intermediate between newspapers and books. Generally speaking, they can plan and prepare their articles more deliberately than newspapers; and, again generally speaking, they are not to the same extent as newspapers, or not so obviously, restricted editorially by considerations of business policy as concerns doctrine or advertising.

One of the leading quality magazines that frequently prints articles by outstanding scientists as well as critical social and philosophical articles continues to carry the advertising of an astrologer. A magazine that prints high-grade articles on applied science in nutrition, health, child training, also carries advertising that is arrant nonsense and in direct violation of its sound scientific teaching. Some of the most "sophisticated" of our magazines, which constantly print biting satire aimed at the absurdities in our commercial exploitations, our provincial credulities, our social inconsistencies, nevertheless print also advertising with extravagant claims designed to exploit commercially the vanities and the ignorances of their sophisticated readers. It seems that one can be very smart about clothes or about investments or about the latest books and scandals and yet be as naïve as any other ignorant person about snake-oil for rheumatism or for velvet skin.

In spite of these inconsistencies, the better magazines, and many not to be rated as first class, as well as the more popular periodicals, are diffusing a considerable amount of scientific information—along with a considerable amount of stimulating imaginative extravagance based on fragmentary hints of "scientific discovery" or invention. The interest of the reading public as pointed out on page 143 calls for an increasing amount of science; and as with the newspapers the quality is probably improving.

From time to time the more serious magazines do print excellent articles on current developments in some branch of science; but with rare exceptions these articles give no clue

whatever for following the subject further, for any readers who might be interested to go to sources or to more technical treatises. The editors seem to fear that the mention of books, journals, or investigators whose names are not generally familiar would repel the reader. The situation is in some ways similar to that of the educational administrators trained in the classical or literary tradition, who still think of "science" as perhaps too earthy to be admitted to the company of cultured people, but who at any rate have no appreciation of the cultural and spiritual values to be derived from a closer familiarity with scientific thinking and its outcomes. It is within the literary tradition to include well-written accounts of explorations, explorations even into the upper layers of the stratosphere or into the depths of the sea; and even the atom has received attention, but chiefly because its manipulation in the laboratory involves wizardry and strains the imagination to conceive the tremendous concentrations of energy in such minute fragments of space.

In addition to the *Science News Letter* published by Science Service, there are several magazines devoted to the popularization of science. A cursory examination of half a dozen of these purchased at the news stands gives the impression that they are definitely *not* addressed to grown men and women, but rather first to the adolescent male, and then to the younger adult who is preoccupied with things and stunts and what may be called, without prejudice, the magic of science. In his address before the Pasadena Division of the American Association for the Advancement of Science in June, 1919, Chester H. Rowell asked in regard to the popular science magazines, "Do they need to appeal so nearly exclusively to the mechanical curiosity of boys? . . . Is there not some way to penetrate the indurated intellects and atrophied imagination of our adult men, also?"[4] For practical business reasons the publishers of these magazines must cultivate as readers large bodies of adults as potential customers for their advertisers. The implications of Mr. Rowell's question must be considered as describing large sections of our

adult population, rather than reflecting upon the editors or publishers of the magazines. As in the case of the newspapers (see page 99 above), there is a necessary relation between the content and tone of a periodical and the character of its special public.

An occasional article on the high-brow stuff of a great scientist of whom everybody has heard will buttress a vast amount of short-unit stuff of the patent-office, record-breaking, shop-wrinkle, clever-solution, police-detective, difficulty-mastering order. The advertising, too, indicates that the appeal is to boys and older men who are interested in machinery, engines, puzzles, shop-work, models, inventions and patents, radio sets, aviation, and so on, although there is also an admixture of plausible hoaxes. These magazines carry a substantial amount of useful and reliable information, and those who read them undoubtedly cultivate a sort of realism in regard to the material world and acquire too something of the spirit of research.

These popular science magazines, like the several special magazines in botany, microscopy, astronomy, entomology, nature study, and so on, reach people who are already interested, know what they want, and who, for the most part, are oriented toward the cultivation of a special interest. We have nothing to correspond to the German magazine *Kosmos*. Our most serious non-technical scientific magazine, the *Scientific Monthly* (originally established by Edward L. Youmans in 1872 under the title "*Popular Science Monthly*, for the educated lay public"), might conceivably attain a wider circulation and influence if it were systematically brought to the attention of the large numbers who would presumably find its contents of interest. None of the general or scientific magazines seems to make any effort to interest the lay reader in the contemplation of science as a way of looking out upon the world.

There was inaugurated in Germany during the past winter (1933–1934) a new semi-monthly magazine under the name *Geistige Arbeit*, which is to give brief reviews of current progress and tendencies in all departments of scientific research. It is

intended to select the writers from among those who have carried on original research in the field of which they write. This is apparently intended to preserve the authenticity of the contents; but it is questionable whether this policy can be long maintained without eventually restricting the choice of subjects to those fields that happen to have in them scientists who can also write suitably. Although this magazine, at 25 pfennige a number, does not pretend to be "popular" in any invidious sense, being offered as a *Zentralblatt* for educated people, it calls forth from *Nature* a comment that is significant in all of our efforts to diffuse science to the adult public.

> In highly compressed articles of this type, it is of primary importance that the authors should have not only a deep insight into their subjects but also a proper sense of values, if the services of a discriminating censor are not to be invoked. Goethe has said: "Die Vernunft ist auf das Werdende, der Verstand auf das Gewordene angewiesen." This remark applies particularly aptly to the present journal.[5]

We miss in the magazines generally offered to the lay public, including those devoted largely to popular science, any serious or consistent effort to interpret to their readers the underlying logic and philosophy of scientific research and its remoter implications for social and individual living, other than occasional "applications" or theoretical discussions. Perhaps the best indication of the editorial unawareness of this aspect of science is to be seen in the constant appearance in the magazines of advertising of a sort that even a moderate degree of scientific enlightenment among the readers would render utterly worthless.

As with the newspapers, we have no way of knowing in advance whether such educational material would sufficiently interest the readers to warrant its publication. Nor, if the editors requested such material, could we readily find the writers to supply it. Nevertheless, if it is important to distinguish between education in science and the diffusion of accepted ideas, it would seem desirable to accelerate the diffusion of thought along these lines by means of magazines.

BOOKS

The book as a means of redistributing the intellectual gains of scientific research and reflection is apparently holding its own. The number of new books in science published each year bears a fair proportion to the total output, and the popular books in science and in the history of science have increased rapidly in the past ten years.

These books, intended to humanize or popularize science for the layman, appeal apparently to an interest or curiosity already present. To arouse such interest anew, it will probably be necessary to rely upon the newspaper, the radio, the magazine, the museum, and perhaps other modes of reaching masses of people in advance of selection.

Guidance in Selection

The individual who has become interested in any field of thought can find in books the material to satisfy his needs; but his first great lack is a means of locating the books that will serve him. The American Library Association has helped countless numbers through its series of booklets, "Reading with a Purpose," which included ten in general science or in the special sciences out of a total of sixty-five (June, 1933).

Perhaps more far-reaching in its effects was the series of twenty-seven "Science Booklists," prepared by a committee of the American Association for the Advancement of Science, under the chairmanship of Dr. Joseph L. Wheeler of the Enoch Pratt Free Library in Baltimore. Over a million copies of these leaflets were distributed gratis by schools, libraries, museums, natural history clubs, and similar agencies, in the course of some three years. The purpose of the series was (1) to selcet and describe a few authentic and especially interesting books acceptable to the "general reader"; (2) to supplement these with several introductory treatises in understandable style; and (3) to suggest a group of textbooks for more advanced study by ambitious amateurs or persons studying by themselves.

Further help in the selection of books, on a somewhat more advanced level, is furnished by the Scientific Book Club, with an editorial advisory board of distinguished scientists under the chairmanship of Professor Kirtley F. Mather of Harvard University. The committee selects a book a month for the subscribers and issues also notations on other books suitable for the guidance of the non-technical reader. Like the commercial book clubs, this performs a valuable service, in its restricted field, to large numbers who are not in a position to make their own selection from among the vast numbers of new books constantly being issued. Indeed, this type of service is of increasing importance for everybody who reads at all, since it is impossible for the individual book dealer or librarian to supply the needed counsel; adequate information from the publisher is seldom sufficiently prompt, and perhaps never sufficiently critical; and the reading of book reviews also involves both a great deal of time and long delays. "First Glances at New Books" in the *Science News Letter* is probably the best available combination of promptness with evaluation.

In many cases a book commends itself by the standing of the author or by the responsibility of those who urge it upon our attention. There are excellent series of semi-popular books in science that can be safely accepted by the layman almost at random—like the "Century of Progress" dollar books issued under the sponsorship of a committee of the National Research Council, and the "Highlights of Modern Knowledge," of the University Society, New York.

General Availability

The famous little "Blue Books" put out in vast numbers by Haldeman Julius included many on scientific subjects. Of these a large proportion consisted of reprints from older sources, but many were prepared to order. Although printed in small type on poor paper, their large sales may be taken to indicate a widespread and continuous demand for short units of serious reading matter on various topics, including scientific and phil-

osophical problems (Will Durant's *Story of Philosophy* first appeared as a number of units in this series). The same content, more carefully written and more attractively manufactured, but at a moderate price, would no doubt find a large public ready to buy such books under normal conditions.

The retailing of books seems to be moving steadily away from the bookstore to the drugstore or the five-and-ten-cent store—that is, to a form of merchandising that calls for a minimum of knowledge on the part of the dealer. This suggests the desirability of planning books in popular science to meet the new buying habits as well as the new leisure and the new patrons.

Certainly it should be possible to produce suitable books on a large scale that would permit low unit costs, if advantage is taken of modes of distribution that are not themselves too costly. In England and on the Continent the news stand sales of small, well-printed, paper-covered books on a variety of topics seems to make for a wider distribution of scientific and other serious literature than we have in this country.

It should be feasible also to reprint suitable books that have demonstrated their value but that have not been made generally available at a low price. The cheap reprint editions usually exclude scientific books, partly because these have not been sufficiently publicized in their trade editions to command instant attention, and partly because so many of them include illustrations, which add to the cost of reprinting from the old plates. It might be worth while to experiment with a number of such books made available at a low price, since the price appears to be a real obstacle to their wider sale.*

Quality

The difficulties in the way of appraising new books, whether by the general reader or by the librarian, are suggested in a review of several well-written books which were intended to make the understanding and appreciation of science more

* Within the past two years the Garden City Press has projected the addition of many scientific books to its cheap reprint series.

popular. The first of these books was criticized because it offers science as in effect a justification of the superstitions that satisfy the emotions: "relativity" is the latest word in science and it enables us to make anything mean whatever we wish it to! Another book was criticized because it emphasized the trivial and superficial incidents in the lives of the scientists, instead of the development of their ideas. A third book, although reliable enough as to its contents, tried "to make every discovery startling."* A similar criticism of a fourth book says that, while the author starts out well enough for the non-technical reader, he depends too much on lively writing rather than on the helpful organization of ideas and soon carries the reader beyond his depth. A recently published botanical book is roundly scored for its misinformation, some of it potentially dangerous for the reader; but these criticisms seldom reach the buyer or even the librarian.

Several introductory textbooks in science make good reading; but, broadly speaking, most textbooks, whether for high school or for college, are not satisfactory for the general reader. Both in organization of material and in style most textbooks seem to be aimed at immature minds that will have to read on whether they like it or not. There is often a certain condescension too, an air of infallibility that repels adults. The more general books, on the other hand, often attain simplicity by omitting the difficult problems that concern the adult. It must be assumed that books for the general reader will be readable and intelligible. There is the further need of including a consideration of methods, doubts, implications, open questions, on an honest, man-to-man basis. It is not the function of popular science to convert the heathen or to conduct propaganda for a true gospel. If such books make clear to the reader the nature of scientific "truth" and the method by which it is pursued, the residual faith may be

* It is, of course, legitimate for both the author and the reader to get all the fun they can out of making the scientists amusing, or their discoveries startling; but that is no more teaching science than is the retailing of gossip about popes a teaching of theology.

left to fate. There seems to be a need for books that are not only readable, intelligible, and trustworthy as to content, but also "humanistic" both in the sense of being sympathetic toward the contemporary individual without condescension, and in that of appreciating the larger swing of mankind's growth and groping.

LIBRARY

The library has, of course, to meet all of these problems of selecting, appraising, guiding, in addition to the problem of financing. In trying to be all things for all comers it is often obliged to make arbitrary decisions.

The selection of scientific books for the library is an important responsibility which the specialist must share while avoiding competitive pressure to bring his department an advantage. An episode that is itself far from typical of college libraries illustrates some of the difficulties to be met. Out of a budget of $5,000 for the purchase of books in one year, at a small college, one-half went for fiction, most of it probably ephemeral; and some 10 per cent for books in astrology, phrenology, fortune telling, etc. "Not a single botanical journal or any important biology books were added." One of the younger instructors requested that a faculty committee cooperate with the librarian in selecting half of the books. Members of the faculty (including the scientists) voted this suggestion down, on the ground that it might impose a censorship on the assistant librarian who was responsible for making the selections! This would seem to be carrying rather too far the division of labor, for the specialization involves the separation from the available technical bibliographical tools and other aids on the part of those responsible for allotting limited funds to satisfy varying and conflicting demands.

The libraries are in general ready to cooperate in any undertaking that promises to increase the use of their facilities and through their organization in the American Library Association have developed several excellent devices for making biblio-

graphical information in specialized fields promptly available. The libraries as institutions and the individual librarians have been helpful in the preparation and distribution of lists and bulletins. Many libraries keep their visitors continuously informed of new books by means of their bulletin boards, of printed or mimeographed announcements, and of exhibits. And in the larger libraries there are available individuals who are familiar with the subject matter and current literature in special departments of interest, so that the reader can get personal advice taken out of current periodicals and reviews rather than information out of obsolescent books on the shelves.

In many centers of adult education arrangements have been made to have on hand suitable books supplied by the local library, ready to be lent to the auditors.

Current Books

The suggestion that newspaper and magazine articles and radio broadcasts and lectures on scientific topics be accompanied by references to reliable and helpful books would no doubt be welcomed by librarians, since it would give them an additional opportunity to make their resources of service. They could feature books thus given publicity, and other books related to the topics discussed.

In general the timeliness of scientific books is likely to be related not so much to the science items that appear in the newspapers on a given day as to other current interests and events. For example, there is a dust storm, Niagara's rim crumbles, there are the August meteorites, an eclipse, multiple births, a snake-bite episode, the uncovering of an ancient temple, the putting of a bridge or a dam into commission, exploratory ventures into the depths or the heights, and so on. Or there are important anniversaries, centennials, memorial exercises, the opening of a special research institute. Or there are current exhibitions and demonstrations that arouse wide immediate interest and yet have meanings that reach into the material hidden in the books on the shelves. This type of

library service calls for wider information, more imagination, and certainly much more time than is usually available. But much of it could be organized and planned in advance, as through the cooperation of libraries over a large area or through the cooperation of scientific and educational groups.

Guidance in Use of Books

In addition to help in the selection of books, many readers would seem to need help in the use of books. Among college students, who presumably have learned to "study," the value of guidance in reading has been frequently noted. In one systematic experiment at the University of Michigan, planned to ascertain the relative effectiveness of lectures and reading, it was found that for understanding and retention of inferences from material presented, as well as for immediate and delayed recall of information, the guided reading was measurably superior to the other methods.[6]

A useful service could be rendered adult readers (many of whom get more from reading than from lectures or have to read if they are to get any intellectual stimulation and help) through the distribution by the libraries of special guides to reading of selected books in science. Such guides would have to be prepared by specially competent teachers and scientists and be made available at a nominal cost or distributed gratis. Like the "Listener's Guides" prepared for radio auditors or syllabuses for academic students, they can be prepared for broad topics or for particular books. Study outlines for special books have been prepared for the use of individuals or of study groups, as for some of the volumes in the "Highlights" series (see page 106). A similar device might prove of great value for groups and for individuals in connection with the diffusion of science.

Guide books are already available for introducing the individual into various fields of *activity*. Manuals in natural history can be featured as leading to outdoor projects of many kinds, as well as to many kinds of laboratory work, as in microscopy, mechanics, electricity, chemistry. There are books and

guides that concern themselves with local areas, parks, flora and fauna, geological features, and others that deal with their materials more broadly. The librarian is strategically situated to bring patrons a changing picture of the various possibilities for an interesting and profitable preoccupation that has all the advantages of an irresponsible hobby as well as those of a dignified and satisfying participation in the human quest for understanding.

Through their contacts with their readers, librarians should be in a position to discover the patrons interested in one or another branch of science, and to help in furthering educational efforts, as by arranging lectures, conferences, demonstrations, etc. In several libraries, revolving exhibits have done much to arouse the interest of visitors and to guide them into fields of reading that they could not easily have found for themselves. In other cases libraries have taken the initiative in planning more systematic work in adult education. In many communities the library is the logical focus for serious but non-academic educational efforts by and for adults. There would seem to be needed the initiative on the part of those interested in science to make these resources available in that field.

[1] E. E. Slosson, "Adult Education in Science," Digest of the *Proceedings* of the Second Annual Meeting of the American Association for Adult Education, 1927, p. 53.

[2] A. N. Whitehead, *Adventure of Ideas*, Macmillan, 1933, pp. 3, 5.

[3] Slosson, *op. cit.*, p. 53.

[4] Chester H. Rowell, "The Press as an Intermediary between the Investigator and the Public," *Science*, August 5, 1919, p. 150.

[5] *Nature*, March 21, 1934.

[6] Edward B. Greene, "Certain Aspects of Lecture, Reading and Guided Reading," *School and Society*, May 12, 1934, pp. 619–624.

XI

SENSORY AND MOTOR AIDS

IT is generally recognized that the transmission of ideas and the stimulation of thought by means of words need constantly to be reenforced, and that visual aids are for most people the most effective. In fact, the conversion of "education" as conducted by schools into an almost exclusively verbal process has been for long condemned as a serious obstacle to genuine educational effort; and the picture book was urged upon educators centuries ago as a means of reestablishing the nexus between words and things!

PICTURES

Education in science calls especially for the seeing of things, and eventually for their manipulation. The still picture, along with the diagram, has been taken for granted in the book, the chart, the projection by means of the lantern. The graphic arts have been making rapid advances in the century since photography became practicable and now furnish substantial contributions to the making of scientific books more effective as well as more attractive, and to the making of scientific lectures likewise. The projection apparatus has also improved so that it makes possible showing not alone prepared slides from photographs and drawings but actual objects, including microscopic preparations, and including living objects in action.

DEMONSTRATIONS

Non-academic lectures and courses in science for lay auditors are frequently accompanied by demonstrations. The lack of facilities for such demonstrations is one of the commonest

limiting factors in the extension of science education to adult groups. The demonstrations are considered essential adjuncts because the science study has to do with real things and with experimental modifications.

These demonstrations are parallel to such aids as the telescope or the planetarium in the teaching of astronomy, of the microscope in the teaching of biology. The scientific demonstration is by many scientists and educators considered a substitute, and a poor one, for actual laboratory work by the students themselves. From the results of special studies made in England and in this country, it becomes doubtful, however, whether the laboratory in which each individual does his own experimenting is as effective in teaching certain facts and principles as are well-prepared and well-conducted demonstrations. It is at any rate probable that the outcomes of the two kinds of experience are different, and that we shall find demonstrations not only more economical but more effective than individual laboratory work for adults, over large areas of instruction.

In some cases there is the danger that good demonstrations will become the main show, that is, that they will take on the form of exciting exhibitions, with the result that the development and clarification of ideas will become slighted. While this danger is, of course, always present, there is every reason for those who have the skill to do so to combine showmanship with their pedagogical efforts.

The use of models and special apparatus designed to facilitate the clarification of complex ideas carries another danger, namely, that the instructor will permit the demonstration to make a lasting impression of its own without carrying over adequately the facts, processes, relationships, principles, which the demonstration is ostensibly intended to convey. Instead of aiding the imagination to grasp what cannot be directly envisaged, the demonstration leaves a memory of tubes, valves, and movements, but no hint of what actually happens in the circulation of the blood, for example, or in the work of a leaf. That all comes down to the danger of letting the accessories

become the main concern, of assuming that equipment and special aids will make up for poor teaching.

While the demonstration can be a valuable, indeed an indispensable, aid in the teaching of science, it is probably sound to assume that, as many writers have suggested, the best teaching will be the kind that leads the learner to undertake some activity of his own. Good organization of science education should therefore include provision for field and laboratory and shop work by as many individuals as can become interested to follow up didactic instruction.

MUSEUMS

The museum has undergone a development in some ways parallel to, though later than, that of the library. The results in the case of the library, which we have come to take for granted, is well brought out by R. L. Duffus:

> The early libraries were collections of books, just as a museum is a collection of pictures, stuffed animals or fossils. They were primarily safe places where books could be preserved and only incidentally where books could be used. The twentieth century library in America is no longer a museum. It is less and less important as a place where books are preserved; more and more important as a place where they are used, worn out and replaced.[1]

In contrast to the traditional operation of fine art and natural history museums as warehouses for the safe preservation of the world's curios and of objects possibly having "historical" interest for the scholar is the growing disposition to organize and conduct museums as having current and dynamic significance for the entire population and, in the case of science museums, as centers and instruments of research.

This change is in part the outcome of a more general participation of the public in the school arts, and of the expansion of horizons brought about by reading, by broadcasting, by the movies, by travel. Provincial as our vast and heterogeneous population may remain in many respects, most of us no longer gape at the sight of an Oriental or stare in amazement at a stuffed ostrich in a glass case. Without becoming altogether

blasé, we increasingly refuse to be attracted to the sideshow of a circus or to a museum in which one may inspect a general's sword or an emperor's crown.

The scholarship which was at one time the only sophisticated justification of the museum has also become to a degree democratized and domesticated. Learning from whatever it is that the museum assembles and exhibits is no longer confined to the professional student: increasing numbers of men and women can get from the museum something more than a solemn awe or a hushed reverence for the marvels, for the vague sages who made mysterious discoveries, for the clever men who fashioned the rare treasures, or for the bold adventurers who brought queer trophies from faraway lands. Wondering about meanings, sources, workings, developments, and curiosities about *how* problems have been solved, come to be widely diffused; and the museum becomes a democratic educational institution to which people will turn in proportion as it serves their needs or wishes.

We still have museums in which the custodianship and exhibition of relics dominate the administration. Perhaps it would be fairer to say that in these museums the display to the public is assumed to be of itself an adequate and sufficient educational service, just as with certain scientists the publication of their results in the technical journals is assumed to be an adequate discharge of their educational responsibilities.* The deliberate planning of museums to discharge their educational functions in terms of a more modern psychology as well as of a more modern social situation is proceeding steadily, however. This type of planning is exemplified in the excellent work being done by such institutions as the American Museum of Natural History and the Metropolitan Museum of Art.

* It is, of course, not to be expected that every scientist shall carry in addition to his research or teaching the task of relating his inquiries to the immediate interest and comprehension of the adult lay public. As has been indicated above (page 75), the individual scientist may well devote himself exclusively to his research; but the institutionalized agencies and groupings must certainly be assumed to have broader educational obligations.

The new arrivals in the museum field—the museums of science and industry—untrameled by tradition are also pioneering in this field, with effective results. Abroad it is illustrated in the development of the Deutsches Museum in Munich, by the reorganization of the science museum in London, and by the establishment of new museums, such as the Hygienisches in Dresden, and many industrial museums.

According to Laurence Vail Coleman, director of the American Association of Museums, the number of museums deliberately conducted with an educational purpose was not more than a few dozen at the close of the World War; at the present time it is in the hundreds.[2] From the point of view of the adult population, the development of new interests in science will lead to increasing demands for educational assistance from the natural history and science museums, as the growing interests in other directions have brought demands for such help from the art museums or libraries.

> The importance of museums will become clearer as these new interests develop, and the time will doubtless come when the Adult Education movement will make much greater use than at present of the resources of national and local museums. Prominent museum authorities have already shown a keen interest in the movement and readiness to help.[3]

From the point of view of the industrial museum the meeting of these demands is suggested by Dr. C. R. Richards, director of the New York Museum of Science and Industry: The first principle of such museums is that they must bring out clearly the physical operations involved in modern industrial methods, in the most effective way, illustrating of necessity the various stages of invention that have led up to present-day usage. Then they should endeavor to "indicate the scientific principles involved in the exhibit." And they must also "set forth in some measure the social and economic implications of industrial progress." This last, says Dr. Richards, "will be the most difficult task laid upon these new institutions beyond doubt, and yet it would seem equally true that without wholehearted endeavor toward this end, they will be left as glorified wonder-

lands, lacking the full educational message they should bring to our people."[4] To some extent the large museums have carried out this last educational function partially and incidentally; but its systematic and wholehearted attack today challenges both the educator and the museum director, as well as the scientist, who has for the most part assumed that the other specialists were doing their tasks well enough to spare him any serious concern beyond his own immediate problems.

A realization of the educational responsibilities of the museum with special regard for the social aspects is indicated by Dr. C. C. Adams, director of the New York State Museum:

> The slow perfection of the scientific method, as worked out in the physical and natural history sciences, is now being consciously extended to those natural history sciences which center about man and which have come to be called the humanities. The application of the same methods of careful, scientific analysis and synthesis is today the primary scientific and practical problem of human society.

Among the functions of the Division of Science and State Museum, he lists the fact-finding or research functions:

> To conduct the state scientific surveys of the natural resources. . . . The rocks, minerals, fossils, plants, animals and . . . special scientific and economic problems, such as relate to sand and gravel, limestones, injurious plants, insects and other animals, constitute an unending succession of field and laboratory studies urgently demanding attention. Not limited to the preliminary or "survey" aspects of these problems, but extended to thorough investigations leading to and bearing directly on broad public policies. There should be some agency that will be primarily concerned with the State's interest as a whole, and not be limited too exclusively to the special, local or sectional interests.

The museum exhibits themselves, he says, are "primarily designed for educational purposes, and are a phase of applied science and art, combined so as to tell a story that the general public may readily understand."[5]

There have been great improvements in museum technique. Both the preparation of exhibits and their arrangement have been made more interesting and more instructive. It has been possible to get closer, or at least longer, attention to individual

exhibits by as much as 30 to 50 per cent through improvements in the labels alone.[6] The label has been increasingly supplemented with fuller explanatory posters, with charts, and with guide leaflets, or even more ambitious supplementary publications in the way of handbooks. It has been suggested that in most cases museum labels could well include references to available scientific books for further reading and orientation. There has been an increasing use of operative models and mechanisms which are under the control of the visitor. In addition to making clear the workings of various natural and artificial mechanisms, these have the advantage that the observer can repeat the operation as many times as he needs for his own satisfactory grasp of the principles involved. Electrical, chemical, and physiological principles and abstract relationships as well as mechanical ideas are well presented through such devices.

In the course of an inquiry as to museum practices for the International Committee on Adult Education, in 1931, information was received from twenty-eight American museums that serve in the fields of science and natural history and archaeology. Among the "facilities for adult education," several of these institutions mentioned their "display rooms for the public," "publications," "answering individual questions," "information on request," "identification of specimens," and "reference library." Twenty of these museums offered courses of lectures to adults, outside lecturers as well as staff members being employed by practically all. Nearly all the museums offered special lectures on occasion or arranged special courses to meet an evident demand. Further developments are suggested by the references to lending collections, exhibition and circulation of scientific motion picture films, promotion of hobby clubs among adults, furnishing headquarters and facilities for voluntary science and nature study groups, nature walks and excursions.

The directors of some of these museums are aware of various factors which definitely restrict their educational activities.

Others seem to be groping about vaguely, disposed to do whatever may be seemly, within the limits of their resources. Half of the twenty-eight report themselves "disposed to increase facilities in the way of more lectures for adults, more work with adult groups and classes, and increase of docent services"; but six others plead lack of funds and do not indicate what they would be disposed to do if they had more money.[7]

The more progressive museums have long cooperated with the public schools in various ways. One of the most helpful services has consisted in the preparation and distribution of loan collections arranged to illustrate various generalizations and principles or merely "types" of rocks, plants, or animals. More and more such collections are being made available to adult groups; and it is to be expected that eventually reserve material for individual study will also become available.

Museums have also cooperated with consumer groups on a larger and larger scale, finding "luncheon clubs, women's societies, hobby clubs, garden clubs," and many others ready to make considerable effort in order to get the benefit of the educational aid of the museum. Museums are making wider use of outside resources, such as the newspapers, the radio, the downtown show window, the bulletin board at the school or the library, and other means of reaching the public. These uses carry their various messages; but in addition they cultivate interest in what the museum is doing and eventually bring more visitors.

The setting up of special exhibits that vary with the season or with changing interests, new discoveries, special occasions, is coming to be a frequent mode of reaching the adult public. The Newark Museum has made a feature of this type of exhibit, enlisting the cooperation of scientists, technicians, and industrial and commercial organizations.

The wide range of contacts established by some museums and the great variety of educational activities that they conduct suggest that in every institution and in every com-

munity there are resources and opportunities for valuable work which are not being exploited.

EXHIBITS

The old-time fair has given way to continuous merchandising. And the sideshow has been replaced by the permanent museum. The industrial exhibit has been making for itself a place in our current pattern of living as a powerful educational instrument. While the purpose of the exhibit is primarily commercial, analogous to that of advertising or propaganda, the educational possibilities are there for those who are concerned with the diffusion of science. At a chemical or automobile or electrical exhibit, one interested in the educational purpose often finds it difficult to distinguish between features that are significant to the visitor as helping to grasp a scientific principle from others that are designed to "sell" a product or a particular producer. In the commercial expositions, as well as in those conducted in connection with the annual meetings of scientific or professional organizations, there is to be seen a great deal of material that is valuable to the lay public not only as giving a glimpse of the advances that are being made, but also as revealing the problems which the specialist is attempting to solve and the methods by which gains are made.

From time to time there are offered at such exhibits lectures and demonstrations and showings of motion pictures that are educational in the best sense. Publicity, lectures, open house, cooperation with the libraries and the schools, and specially designed educational features suggest themselves as feasible.

EDUCATIONAL USE OF OUT-OF-DOORS

It is difficult to classify and unnecessary to describe in any detail all the educational activities that have overflowed from schools and museums to the surrounding world. The zoological garden has come to be something more than an animal show, and the botanical garden something more than a hybrid between the pedantic and the precious. Increasingly have educational

activities accompanied the research work of these institutions. Beginning perhaps with courses in gardening or in naming the birds, and with guided walks through the grounds, these gardens have branched out in all directions; and like museums and university extension divisions they adapt themselves to the needs of the public.

The extension of such educational activities along with the redirection of the public's attention is proceeding rapidly and is emphasized in the report of the committee on Nature Study and Outdoor Life of the National Commission on the Enrichment of Adult Life, of the National Education Association:

> Two generations have passed since Agassiz enjoined the students at Penikeese to "study Nature, not books." There was then gathered, on that remote island in Buzzards Bay, a group of naturalists who caught the spirit which has since enriched the life of multitudes [and which, we may note, has completely transformed the investigation and the teaching in the biological sciences]. . . . Three-score years have wrought marvelous change. The textbook has given place to the laboratory. . . . The lecture room is being abandoned for the field. Facts have taken the place of fancies. Charts, models, and lantern slides are giving way to contacts with real things. . . . At about the time that educational institutions began to make their courses of instruction objective, it dawned upon the museums that among their other commendable activities was the function of stirring visitors to go into the field to study Nature and then return to the museums as places of reference and further information. Thus, museums of science frequently have become a feature of parks—national, state, municipal, and private. To these have been added the Trailside Museums (small unit structures by the roadside, designed to interpret the features of certain chosen localities) and the so-called Nature Shrines which tell the story of some individual exhibit, made by Nature, and which is worthy of special attention. Even more intimate is the nature trail, where the visitor may wander quite alone and find along his path a series of readable tags bearing the information that might be given him were he accompanied by a well-posted naturalist friend.[8]

As the separation between the museum or park and the rest of the world becomes obliterated, the distinction between "education" and "recreation" also fades out. People hunt mushrooms or join the Izaak Walton League for fun and continue their activities so long as these are satisfying. How much

science, or how much education, emerges from the experience depends upon the individual and what he brings with him as well as upon the conditions and opportunities. The institutions can furnish opportunities, perhaps stimulation, and make sure that the availability of these opportunities and services is brought to the attention of those who can benefit from them.

PARTICIPATION

More and more, the educator finds that action is essential to learning. The advance of science has come about through the experimental method, that is, through the constant translation of thought into action with further revision of thought as a result of the action.

On every level of education in science, and for adults as for young people and children, it becomes necessary for the learner to take part in the processes that bring forth scientific ideas and understanding. It is for these reasons that the wider use of the realities of the outdoors, under suitable guidance, is so well worth cultivating as a means of extending science. One may begin with collecting and get no further than naming; but the path is endless and the important thing is to get as many as possible on to the path.

MOTION PICTURES

For the past fifteen or twenty years more and more attention has been given to the possibilities of the cinema as an aid in science instruction. The earliest efforts to bring the motion picture into the service of education were largely dominated by the commercial interest in getting multiple use—and multiple pay—for films that had already been completed for recreational or other purposes. The educators were slow both to make demands upon the new industry for films deliberately designed to serve their ends, and to experiment on their own account with the new instrument. Non-commercial experimentation with the motion picture seems to have begun in the

laboratories of research workers needing a means of recording phenomena that could not be satisfactorily reproduced otherwise, a means of analyzing movements of all kinds; in industrial and commercial organizations as a means of instructing workers, salesmen, and others in standard practice and in the workings of their special appliances; and in educational propaganda by the governmental and other agencies interested in promoting health, standard usage in agriculture, and other non-commercial ends.

The advantage of the motion picture as a means of impressing the observer was appreciated from the first; and it was indeed predicted that this instrument would eventually displace the teacher—just as more recently many have hoped or feared that the radio would displace the teacher. The value of the cinema in education has come to be more sharply defined as study and observation have brought out the distinctive effects that it can produce, as against still pictures, on the one hand, and experience with real things, on the other. It is necessary to recognize the limitations of the instrument if the optimum use is to be made of it.

Numerous technical studies have been under way to discover the most effective methods of using the film in education, and to discover its relative effectiveness as against other educational procedures. The specific feature of *motion*, whether in photographs of actual things, people, animals, rivers, and other natural phenomena, or in charts, machines, models, and other artifact, enables us to clarify ideas of complex relationships, especially relationships involving time, without reliance upon technical vocabularies or circumlocutions in the vernacular—and more effectively than is possible with any verbalizing.

The motion picture has the disadvantage that it can be very dogmatic. Unless what it shows is suitably qualified and interpreted, the ordinary spectator carries away convictions that rest on an ineradicable impression, since for most people "seeing is believing." This is not because the film is necessarily false as to what it shows, but because what one sees is not necessarily

adequate testimony for what one thinks it means. The combination of sound with film is making possible both the refinement of the teaching and the strengthening of the impression, so that there is now at hand a powerful device for teaching movements, operations, processes in the actual world of experience, and for elucidating interpretations and abstract concepts of high degrees of elaborateness and complexity. Undoubtedly it will be possible to produce sound films that are for certain limited purposes virtually autonomous, that is, capable of delivering their educational messages effectively without the direct aid of a teacher. This does not threaten, of course, to make educational institutions automatic and mechanical; it means that the function of the teacher must more and more come to be of a kind that cannot be performed by a machine—an important advance toward humanizing education and toward developing understandings.

The advantages of the motion picture for scientific education have been generally recognized. In the symposium "Can the Films Educate," Mary Field says, "For showing how machinery works, how buildings are balanced and planned, how chemical reactions take place and how trade movements are directed, there is nothing to compare with the animated cartoon, and we have hardly yet begun to experiment with its use in instruction."[9] But beginnings have been made for using both direct photography and the animated cartoon and model; experiments are actually under way in many institutions, both in this country and in several foreign countries.

Notable scientific films have been made in every field of scientific interest, especially designed to inform, to enlighten, to elucidate, not merely to tell. Perhaps the most ambitious undertaking is that of the University of Chicago in cooperation with the Erpi Picture Consultants. Although these sound films are planned primarily for classroom instruction for undergraduates in the general science courses, they should lend themselves admirably for use with adult groups. Some of these films have in fact been used experimentally with lay groups;

but much more experience will be needed before their special value and effectiveness can be estimated. The plans for these films and their relation to the reorganization of undergraduate instruction at the University of Chicago are of interest here because they point to educational objectives more closely akin to those of adult education than college efforts heretofore have commonly manifested.[10]

Our traditional identification of the film with the theater has led to two other types of suggestion: (1) How can educational films be introduced into the commercial motion picture theater? (2) Would it be feasible to develop a motion picture theater for the presentation of science to adults?

On several occasions "scientific" films have been put before the public as separate exhibitions—that is, apart from any recreational program. The "Relativity" film drew large audiences and was at least for a time commercially successful. The "Evolution" film also attracted a good deal of attention, but the backers went into bankruptcy and further promotion was suspended. In both cases there is no doubt that these films attracted almost entirely because of the wide publicity that the theme topics had been receiving at the time. "Relativity" was a challenge because it invited the ordinary individual to match his wits against the handful of giant intellects who were alleged to be alone capable of understanding what Einstein was saying. The film also intimated a clarification of the great mystery which promised to satisfy genuine curiosity. The "Evolution" film came while the echoes of the Scopes trial were still resounding and had received a great deal of denunciation from prominent fundamentalists. As to the merits of the films, educationally, there was no doubt room for much improvement. Arctic, African, and other exotic films, including one purporting to present the lives of the dinosaurs, had fair to good commercial runs, although educationally they left much to be desired.

Short units on various scientific subjects have been introduced from time to time in commercial theater programs as fillers;

it is impossible to form any judgment as to the value of these educationally, or as to the reception they received.

Various university extension divisions, museums, and city departments of education have been using scientific films in their adult education programs; and others are planning to do so when arrangements are completed. In 1931 there were estimated to be 350,000 non-theatrical projectors in use in this country, owned by schools, voluntary educational, propaganda, and religious organizations, commercial companies, and individuals. And more than thirty-five "reliable commercial companies" were producing non-theatrical films. These films are being distributed by some two hundred commercial companies, by voluntary associations, schools, museums, and government bureaus.[11]

According to Cline M. Koon, specialist in radio and visual education of the United States Office of Education, there is need for a central agency or institute "(1) to assemble, edit, classify, publicize, and catalogue non-theatrical film material, and to set up a convenient and economical distribution system; and (2) to produce and stimulate the production and effective utilization of educational films."[12] The need for experimental work in this field for the special service of science education among adults could perhaps be served at least in part through cooperation with groups interested in the larger educational program.

DRAMA

The dramatic possibilities of the controlled movements depicted by the cinema have suggested also that in the development of educational devices for furthering science among adults the drama be called upon to yield its specific values. In the past there have been dramatized the lives of Louis Pasteur and Walter Reed. The film based on Sinclair Lewis's *Arrowsmith* presents some of the problems and issues that arise in the life of the scientist, as did the play "Wings over Europe." These

plays and films and others like them were not primarily concerned with the presentation of the scientific problems or procedures; but the history of science would yield many episodes that could be made into good drama that is at the same time educational. And in many cases such drama would lend itself to presentation through the cinema.

Showing with the aid of the various means which have been suggested is, from an educational point of view, a step in advance of telling. Dramatic presentation, when effective, is a step further in the direction of active participation, but only to the extent that the spectator or auditor is made to identify himself eagerly with one or another of the characters or protagonists. Indeed, the effective teaching, in science as in other fields, depends upon making the learner feel a genuine concern for outcomes, for the results of an experiment or even a computation.

[1] R. L. Duffus, *Books, Their Place in a Democracy*, Houghton, 1930, p. 145.

[2] Biennial Survey of Education in the United States, 1928–1930, Chap. XXII, advance pages; *Bulletin* 20, 1931, U.S. Office of Education, p. 32.

[3] "Memorandum on the Increased Possibility of Cooperation between Public Museums and Public Educational Institutions," *Educational Pamphlet* 87, Board of Education, London, 1931, §19.

[4] Charles R. Richards, "The Museum of Science and Industry," *The Museum News*, April 15, 1934.

[5] "Public Functions of the Division of Science and State Museum," *N. Y. State Museum Bulletin* 288, Albany, 1931, pp. 61–70.

[6] Edward S. Robinson, "Psychological Studies of the Public Museum," *School and Society*, January 24, 1931, pp. 121–125.

[7] Unpublished material assembled in 1931 by the American Association of Museums.

[8] *Report* of Committee on Nature Study and Outdoor Life. National Commission on the Enrichment of Adult Life, National Education Association, Washington, 1933.

[9] Mary Field, "Can the Film Educate?" in *For Filmgoers Only*, by Paul Rotha and others, R. S. Lambert, editor, Faber and Faber, London, 1934, p. 61. (Published for the British Institute of Adult Education.)

[10] Chauncey S. Boucher, "Talking Motion Pictures in the University of Chicago's New Educational Plan," *Education*, February, 1933; H. B. Lemon, "The Use of the Talking Picture as an Additional Educational Tool at the

University of Chicago," *Journal of the Society of Motion Picture Engineers*, January, 1934, pp. 62–67.

[11] Cline M. Koon, "Motion Pictures in Education in the United States: a Report Compiled for the International Congress of Educational and Instructional Cinematography," U.S. Office of Education, *Circular* 130, Washington, 1934, p. 43.

[12] *Ibid.*, p. 44.

PART III

THE EDUCATIONAL SITUATION

XII
THE SPREAD OF SCIENTIFIC KNOWLEDGE

IN the report on science teaching in adult education, prepared by a committee of the British Association for the Advancement of Science, 1933, attention is called to the fact that when the association was formed in 1831 it was explicitly designed "to bring leading scientific men from London and the universities into occasional conference with local workers, as well as local workers with each other."[1] That is to say, the scientists were recognizing the need for systematic meeting and intercourse for exchange of thought among various classes of workers. In the following half century, numerous associations and institutions devoted to the study and promotion of science took form. Lord Brougham, later the Lord Chancellor, founded the Society for the Diffusion of Useful Knowledge, which began a century ago the publication of the *Penny Magazine* and the *Penny Cyclopædia*, for which he succeeded in obtaining contributions from many distinguished scientists of the time.

In this country, as among industrial nations generally, science rapidly captured the attention of the public because it was a vital factor in magnifying the day's work. It was about a hundred years ago (1837) that there was formed in Chicago, which then had a population under five thousand, the Mechanics' Institute, designed "to diffuse knowledge and information throughout the mechanical classes; to found lectures on natural, mechanical and chemical philosophy and other scientific subjects; to create a library and museum for the benefit of mechanics and others; and to establish schools for the benefit of their youth, and to establish annual fairs."[2] Only a few years before that the American Institute was

founded in New York, to advance the mechanical arts through annual expositions and the awarding of medals and through a broad, though rather loose, program of education.

Agricultural communities attended to science, in general, later than urban communities only because science, through modifying technology, struck industry first and indeed built up industrial cities. The attention to science came in fact largely from demands which technological changes made upon the daily activities: one had to know more and more about new devices and new processes to hold his job or to maintain production (and earnings); and one had to understand the new principles being applied to hope for advancement. Hence mechanics' institutes arose as adjuncts to jobs, just as the institutes conducted by the grange or by the county agent came as essential supplements to the farmer's job, or as instruction in home economics or child caring carried the new knowledge to the home maker.

From the very first the distinctive "realism" of science demanded the demonstration and the "lecture with experiments" and for many years these have been distinctive features of science teaching.

THE PRINTED WORD

New knowledge concerning science, like new knowledge generally, could be transmitted by the printed word, supported occasionally by pictures or diagrams and there has been a continuous rise in the number of books published in the fields classified by librarians as "science" and "technology." The Library of Congress classification "Natural Science" (Class Q, which includes the history and philosophy of science) showed an increase in new titles of 3.56 per cent between 1932 and 1933, and the class "Technology," an increase of 10.10 per cent during the same period.

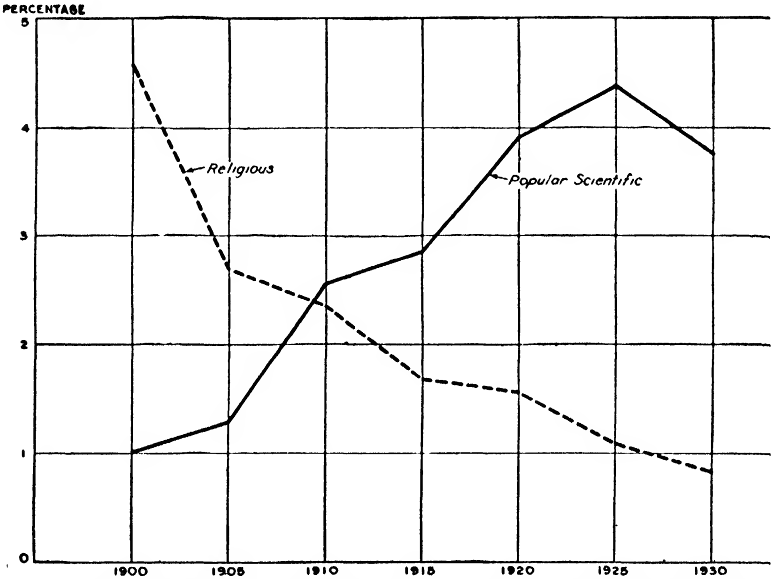
The increase in the circulation of magazines devoted to popularizing various phases of science is graphically presented by Hornell Hart in the Report of the President's Research

Committee on Social Trends.[3] He notes an interesting parallel between the increase in magazine circulation and the rise in high school and college enrollments in the course of one generation. From 1890 to 1930 high school enrollments increased, on the average, more than 100 per cent in each decade. In the same period college enrollments increased an average of over 55 per cent per decade. While the circulation of the magazines covered by Dr. Hart's study rose between 1900 and 1930 from 5,371,000 to 33,366,000, or an average increase per decade of 80 per cent, the circulation of six popular science magazines advanced in the same period from 57,000 to 1,243,000, an average increase per decade of 180 per cent. These increases were, of course, not uniform from decade to decade, but they indicate a general trend. Not only have the popular scientific magazines increased their circulation, but the general magazines have devoted an increasing amount of space to scientific topics, although the purely theoretical phases of science have been receiving a "smaller fraction of this growing attention to science," according to Dr. Hart.

Since 1900 the attention given by newspapers to science topics has also increased markedly. The amount of space given to science in the daily press has been estimated to have increased twentyfold in ten years. Credit for a great deal of this growth in interest should be given Science Service, a joint undertaking of the National Academy of Sciences, the National Research Council, and the American Association for the Advancement of Science, started in 1921 with the late Edwin E. Slosson as director.

As indicative of the shifting interests, Dr. Hart measures the contrasting trends in the circulation of religious and scientific magazines (see figure on following page): here is shown a decline in the relative circulation of Protestant religious magazines over a period in which there was the marked increase in the circulation of scientific magazines already discussed. Hart observes that the "most fundamental change in the intellectual life of the United States in the data covered

by this study is the apparent shift from Biblical authority and religious sanctions to scientific and factual authority and sanctions."



Percentages RELIGIOUS and SCIENTIFIC in the Total Circulation of Representative Periodical Groups, 1900–1930. (*After Hart, in Recent Social Trends in the United States, p.* 391.)

SCIENCE IN THE SCHOOLS

How does the apparent ascendancy of science in the reading interests of the American public compare with the place of science in the schools during the same period?

A canvass was made of the high school studies actually pursued by the graduates of five classes (1890, 1900, 1910, 1920, and 1930) in five cities (Washington, Denver, Joliet, Ill., Long Beach, Calif., and Providence).[4] This showed a marked decline in the percentage of time devoted to the foreign languages, as we should perhaps expect; but also a decrease, though not so great, in the sciences and mathematics.

THE MEAN PERCENTAGE OF WORK IN SCIENCE TAKEN BY THE GRADUATES OF THE SIX HIGH SCHOOLS STUDIED[5]

1890	1900	1910	1920	1930
17.7	13.0	13.3	11.2	10.1

At the same time the percentage of schools *requiring work in science* as a condition of graduation has increased steadily and rather consistently; and to a slight degree there has been a tendency to increase *the amount* of science work required. In the commercial courses, the percentage of the schools studied that required science units increased from 60.9 to 65.6 in the period 1914–1915 to 1930–1931; and in the college-preparatory courses the increase for the same period was from 78.6 to 84.9 per cent requiring science.[6]

The decline in the percentage of work in science done by the high school students in the successive five-year periods is in part explained by the fact that with the rapid growth of high school attendance, and with the rapid expansion of optional studies, there was a corresponding amount of attention given to the new subjects, especially the social studies, the vocational studies, and to the non-academic activities.*

A compilation of the enrollments in the sciences in a large proportion of the public high schools showed that half the students were actually working in one or another science field. The table on page 138 is condensed and adapted from the Biennial Survey of Education for 1926–1928, of the United States Office of Education.[7]

* The number of "subjects" offered by public secondary schools increased steadily from a meager nine in 1890 to forty-seven in 1928:

Years. .	1890	1900	1910	1922	1928
Number of subjects. . .	9	18	23	43	47

From the Biennial Survey of Education, 1926–1928, U.S. Office of Education, *Bulletin* 16, 1930, pp. 1057–1058.

Year	Number of High Schools	Number of Students	Enrolled in the Sciences*	Percentage in the Sciences
1910	10,213	739,143	497,945	60.7
1915	14,647	1,165,495	614,957	52.8
1922	15,598	2,155,460	1,162,223	53.1
1928	16,941	2,896,630	1,467,481	50.0

* Physics, chemistry, physical geography, zoology, botany, geology, astronomy, and biology from 1915, and general science for 1922 and 1928.

In the foregoing tables, physiology, agriculture, and home economics are deliberately excluded although covered by the survey, because they are not, except in rare instances, taught as sciences. If these were included, the percentage of high school students enrolled in the sciences in the four years would be, respectively, 84.0, 82.3, 75.7, and 71.4.

While the percentage of time given to science by the boys and girls who graduate from the high schools may be less than was the case a generation ago, a larger proportion of boys and girls of high school age are actually exposed to systematic instruction in the sciences. This means also, of course, that a large proportion of the total population is today exposed to such instruction; for while the changes in age distribution have reduced the proportion of children fifteen to nineteen years of age from 10.5 per cent of the population in 1890 to 9.4 per cent of the population in 1930, the increased school attendance has more than made up for the change, so that by 1930 *the proportion of the total population studying science in the high schools alone was three times as great as was the proportion of the population enrolled in all the high schools and colleges in* 1890.

Of the graduates in the class of 1930 from the high schools of the five cities mentioned above (page 136) "ninety-five per cent studied some science in high school. In all the cities except Joliet, from two-thirds to nine-tenths of the graduates had studied one or two sciences. In Joliet more than half the graduates studied three or more sciences."[8]

The remarkable expansion of high school enrollment, with only a moderate increase in the amount of time given to science,

has the effect of extending science instruction to an increasing proportion of the entire population.

SCIENCE IN THE COLLEGES

In sixty years the sciences have steadily attained an ever larger place in the work of the colleges and universities. Among the findings of the National Survey of Secondary Education are some significant data on the relative time given to science in high school and in college by several groups of college graduates of the class of 1930. The median percentage of time given to the natural sciences while in high school was 11.1; and the median percentage of time while in college was 18.9.

THE PERCENTAGE OF TIME IN NATURAL SCIENCES DURING HIGH SCHOOL COURSE AND DURING COLLEGE COURSE BY GRADUATES OF CERTAIN COLLEGES IN 1930[9]

College	High School Science	College Science
Vassar	4.2	16.9
George Washington	9.1	14.6
Princeton	6.7	18.9
Chicago	11.1	23.7
Wyoming	12.9	22.2
Denver	13.4	17.0
Leland Stanford	13.4	21.7

It will be noted that in every case the students gave more time to the sciences while in college than while in high school, and that the range of variation in the percentage is not so great in the colleges as in the high schools.

In general the schools and colleges have been giving more attention to science instruction: it has come to be taken for granted that science is a part of "education."

In the colleges as well as in the high schools the rapid increase in enrollments in the course of forty years has modified the character of the student body, and with that the character of the demand upon the institution. While there has been a great

intensification of the demand for science instruction for both academic and vocational purposes, there has been also a great diversification in the collegiate program. As a result, nearly every high school and college graduate of recent years has had some work in the natural sciences; an increasing number have concentrated upon science work, although the average percentage of time given to science by all students may have declined.

These indications as to the place of science in collegiate institutions take no account of the rapid extension of science instruction in the professional fields. The engineering schools, the agricultural colleges, and the medical schools have demanded increasing attention to science; and on the secondary level the mechanics institutes and various vocational schools have done likewise. On the whole, then, science has come to be a normal part of the systematic education of a rapidly increasing proportion of the entire population.

[1] British Association for the Advancement of Science, *Science Teaching in Adult Education*, 1933, p. 330.

[2] Austin H. Clark and Leila G. Forbes, "Science in Chicago," *Science Monthly*, June, 1933, p. 557.

[3] President's Research Committee on Social Trends, *Recent Social Trends in the United States*, McGraw-Hill, v. 1, pp. 382–442.

[4] A. K. Loomis and others, "The Program of Studies," *Monograph* 19 of the National Survey of Secondary Education. (*Bulletin* 17, 1932, of the U. S. Office of Education, Washington, 1933.)

[5] *Ibid.*, p. 246.

[6] *Ibid.*, p. 148.

[7] *Bulletin* 16, 1930, Biennial Survey of Education, 1926–1928, U. S. Office of Education, p. 1057.

[8] A. K. Loomis and others, "The Program of Studies," *Monograph* 19 of the National Survey of Secondary Education, p. 242. (*Bulletin* 17, 1932, of the U. S. Office of Education, 1933.)

[9] *Ibid.*, pp. 254, 256.

XIII

SCIENCE EDUCATION FOR ADULTS

IT has been impossible to survey the entire field of adult education in order to find just what place is occupied therein by science teaching. Samples have been obtained from various sources, and these show with fair consistency that the attention given to science in the organized classes or courses is of the order of 5 to 6 per cent of the total.

TYPES OF ORGANIZED ACTIVITIES

University Extension Courses

In the *Handbook of Adult Education*[1] 38 university extension divisions are listed with dated information as to the number of courses offered and the total registration. Letters were sent to the directors of these services, inquiring as to the number of courses in the sciences and the enrollment therein. Comparable information came from 17. One of these represented almost entirely technological interests and is therefore not included. In the 16 institutions for which information was tabulated, there were offered (1931–1932) from 27 to 1,316 courses, a total of 5,637 courses. The enrollment ranged from 1,196 to 30,970, with a total of 119,380 students. The ratio of science courses to total offerings ranged from 0.6 to 22.2 per cent; and the ratio of enrollments in science to the total enrollments ranged from 0.2 to 15 per cent. When all the information from the 16 university extension divisions is combined, we find the following:

Total		Science		Percentage of Science	
Courses	Registration	Courses	Registration	By Courses	By Registration
5,637	119,380	262	6,036	4.4	5.3

Evening High Schools

A sample of enrollment in the evening high schools was obtained from Philadelphia, for the fall term of 1933. In the non-vocational (or non-technical) courses there were registered 3,869 students. Some of these were dropped, and some attended in more than one course. The "pupil-period attendance" was 3,899. The students registered in the sciences were 240; the pupil-period attendance in the science courses was 339. The ratio of registration in science to total registration was 6.2 per cent; and the ratio of pupil-period attendance in science to the total pupil-period attendance was 8.7 per cent. This would indicate a larger interest in science than is found among the generally older registrants in the university extension courses; but the ratio for science is lower than that for the corresponding groups in the day high schools.

Correspondence Courses

The University of Oklahoma reported the total enrollments, by subjects, in the correspondence courses over a period of eleven years, 1922–1933.

The total enrollment was 11,869 students. The subjects that might be considered as falling within the category "science" appeared in the report as follows:

Zoology	42
Geology and geography	134
Physiology	8
Psychology	707
Total "science"	891

That would mean that 7.5 per cent of the correspondence course work was in the sciences. It may well be questioned, however, whether the "psychology," which covered nearly 80 per cent of this science group, and nearly 6 per cent of the total, should not be discounted as science.

Lectures

It has been impossible to form any estimate of the extent to which popular educational lectures include scientific subjects. The adult education councils and the sponsors of lecture courses do not keep their records in a way that would make easily ascertainable the distribution of attention among various lines of interest. A brief history of the "Free Lecture System of the City of New York"[2] reports the number of lectures and the total attendance for each year over a period of twenty-five years. There is frequent reference to noted scientists who took part in the lecture courses and to titles of lectures and of courses. Only at one point is there an approach to a quantitative classification of the subjects of instruction. During the third season (1890-1891) there were given 185 lectures with a total attendance of 78,295; and 31 lectures are enumerated under five headings: Physiology and Hygiene (3); Natural Science (10); Travel (9); History, etc., (4); and Literature and Social Science (5).[3] On the assumption that each lecturer appeared about the same number of times, "Natural Science" had nearly one-third of the total program. In subsequent years, however, that proportion was by no means maintained.

During the year 1933–1934 the New York Council of Adult Education made an analysis of all programs available, according to subjects offered. From Miss Winifred Fisher, executive secretary of the Council, comes the information that

> . . . out of 9,642 adult education offerings, 9 per cent are in the field of science. Seven per cent of the offerings in occupational training are also in the field of science, such as engineering. The chief items offered to the layman in science are in the realm of health and hygiene and mathematics.

There is further comment that "most of the subject matter of science which would give training in the methods of science is in connection with or limited to occupational training."

Workers' Educational Classes

The Workers' Educational Association of England reported for 1927–1928, in England, Scotland, and Wales, a total of 1,683 classes, of which 64 were in the natural sciences—that is, 3.8 per cent.[4] In a compilation to show the distribution of time given to various subjects in twenty workers' educational institutions in various countries, the number of hours given to science (in the curricula of all the schools) was 5.6 per cent of the total. There was a wide variation, however, from no science at all in fourteen of the schools to 10.2 per cent in the Genossenschaftsschule of Hamburg and 15.6 per cent in the Folkhögskola at Brunnsvik, Sweden.[5]

Hader and Lindeman found that, in thirteen districts in England in 1925–1926, the combined tutorial and one-year classes of the Workers' Educational Association, under the auspices of fourteen university joint committees, came to a total of 1,239 courses, of which thirty-seven classes were in science and mathematics. This is equivalent to 3 per cent for science and mathematics.[6]

For the year ending October, 1926, the Workers' Educational Association of New Zealand had enrolled 5,489 students in its various courses. Of these 174 were recorded as in the natural sciences, about 3.2 per cent.[7]

At the Rand School of Social Sciences, in New York City, the natural sciences had been consistently included in the curriculum from the establishment of the school in 1906. For the three years 1925–1928 there were 3,229 registrations in the systematic courses. The registrations in science, evolution, and hygiene were 194, or 6 per cent.[8]

A summary of workers' education courses in the United States during the six-year period 1920–1927 showed only 3 per cent of the courses to have been offered under the general designa-

tion "science," in addition, however, to 1.5 per cent under "health" and 6.7 per cent under "psychology," as shown in the following table:[9]

WORKERS' EDUCATION COURSES
United States 1920–1927

Language and expression	30.0
Economics	16.8
Sociology	11.0
Labor and trade unionism	10.6
Psychology	6.7
Politics, government, law	4.7
Historical (general)	4.2
Science	3.0
Arts	3.0
Women's interests	1.5
Health	1.5

Miscellaneous

Free day classes for men and women were conducted jointly by the New York State Department of Education, the State Temporary Emergency Relief Administration, and the Board of Education of the City of New York during the winter of 1933–1934, primarily for the unemployed, in twenty-five centers. Some five hundred classes were announced; there was only one in chemistry and one in physics, both at the same school; and nine classes in psychology, in various centers. There were, however, some twenty additional classes in a variety of technical or vocational subjects which can hardly be taught without the inclusion of a considerable amount of scientific information, and which *may* be taught to include both a substantial body of scientific principles and an introduction to the methods and philosophy of science. Among the subjects included in the schedules of T.E.R.A. classes were the following: child care; dietetics; electricity and wiring; engineering (various); gardening; heating and ventilating; hygiene; mechanics; machine shop practice; motors and generators; photography; radio; refrigeration; steam and diesel engines.

The Institute for Adult Education of the DeWitt Clinton High School, New York, designed primarily for the parents of high school students, to help them "keep abreast of their sons and daughters," offered in the spring term of 1934 twenty-six courses, including one on "Science in the Home," and one on "Elementary Human Biology." This means 7.7 per cent of the work given to science.

APPARENT DECLINE OF POPULAR INTEREST IN SCIENCE

In contrast to the amount of time given to science instruction in schools and colleges, the proportion of science classes in adult courses seems rather small. Moreover, a comparison of current interest in science classes outside schools and colleges with the conditions of a generation ago also points to a decline of such interest.

The science classes of the university extension departments of the English universities have been sharply reduced in numbers during the past fifty years. This is indicated by the statistics given in the report on "Natural Science in Adult Education" published by the Adult Education Committee of the Board of Education (London, 1927, p. 13):

	Courses Delivered	Science Courses	Percentage of Science Courses
Cambridge University (local lectures):			
1882–1887	377	189	50
1901–1906	552	156	28
1921–1926	367	52	14
Oxford University (extension courses):			
1886–1891	476	127	27
1901–1906	706	152	22
1921–1926	454	44	10
London University (extension courses):			
1882–1887	288	120	42
1901–1906	863	251	29
1921–1926	926	35	4

The Council of the British Association for the Advancement of Science, at the Newcastle meeting in 1916, appointed a committee to look into the "Popularization of Science through Public Lectures." This committee found that "popular lectures on scientific subjects do not usually attract such large audiences as formerly in most parts of the Kingdom."[10]

There is not sufficient information available to answer definitely the question whether interest in science among the adults generally has declined, since there are many varieties of interest, and such interest as there is manifests itself in many different ways. A sample of university extension registrations in the sciences at one institution shows an increase from 1927–1928 to 1929–1930 (416; 589; 627) and just as clear a decline from 1930 to 1933 (574; 560; 405).[11] This is offered as a sample of replies received to the question under discussion, but the writer doubts very much whether it is either representative of conditions generally or indicative of the decline which many observers report. The University College was in the process of development and the increased registration, generally as well as in the sciences, was probably related at least in part to the vocational and technological requirements of the community—especially for chemists in the industries and for teachers of science in the junior and senior high schools. The decline since 1929–1930 reflects the general economic conditions—that is, (1) attendance upon courses requiring tuition payment declined, and (2) interest in economic, political, and social questions increased rapidly among all classes, to the subordination of "science" and other "cultural" subjects.

While those in charge of lecture courses and extension classes deplore the seeming loss of interest in science, other observers are confident that the interest actually is greater than ever and constantly growing. Dean Chester D. Snell, of the Extension Division at the University of Wisconsin, writes that the interest in science on the part of adults seems to be increasing but adds, "However, in my judgment it is not increasing as rapidly as the interest in sociology and economics." Professor J. R. Spicer,

director of the Opportunity School, Toledo University, writes that the large attendance upon psychology classes "is a valid indication of the value which the general public attaches to courses in this field" but doubts whether so many students could have been drawn into science "without an extensive advertising campaign." Dr. Austin H. Clark, who has for many years served as director of the press service for the American Association for the Advancement of Science and the associated societies, writes:

> The steadily increasing public interest in science in this country is shown especially by the progressively increasing amount of space devoted to science in our newspapers, by the appointment by the press of special science writers to take care of the demand for accurate scientific information (there are now nineteen or twenty of these), and by the increasingly frequent recognition of science writers by academic organizations. . . . At the meetings of the American Association for the Advancement of Science there is now no distinction made between the accredited press representatives and the scientific members. . . . According to . . . [my] interpretation, public interest in science is most accurately measured in terms of newspaper space.

Dr. Clark is contrasting the decline of interest in science in England with the growth of interest in this country—as measured by newspaper space devoted to science. He emphasizes this contrast further by calling attention to the fact that, whereas most of the science news in the English papers is furnished to the editors, practically ready for use, without charge, most of the scientific news in the papers of this country is gathered by paid men and edited at a considerable cost to the publishers. Dr. J. McKeen Cattell and Dr. John C. Merriam are also of the opinion that the newspaper space devoted to science is a fair indication of the relative expansion of interest on the part of the public.

It is generally felt, however, that much of the newspaper science falls far short of having a genuine educational value. The individual whose interests in science call for more clarification, more interpretation, more elaborate relating to his curiosities, is obliged to seek elsewhere. The question really

becomes, "Are *such* interests in science on the increase or on the decline?"

The question itself perhaps needs interpretation in terms of the forces that have brought about the changes in our practices as to "educational" processes. Why have interests changed? Which interests have changed? How do the interests in question seek satisfaction?

[1] *Handbook of Adult Education in the United States*, 1934, American Association for Adult Education, pp. 258–272.

[2] *Education for Adults: the History of the Free Lecture System of the City of New York*, Department of Education, The City of New York, 1904. (Apparently prepared for the Louisiana Purchase Exposition at St. Louis.)

[3] *Ibid.*, p. 9.

[4] Marius Hansome, *World Workers' Educational Movements, Their Social Significance*, Columbia University Press, 1931, p. 60. (In a footnote Hansome says that in the reports for the two previous years the order of importance of the various subjects was practically the same.)

[5] *Ibid.*, Table V, p. 88.

[6] John J. Hader and Eduard C. Lindeman, "What Do Workers Study?" Workers' Education Research Series, *Monograph* 2, Table III, p. 23.

[7] Hansome, *op. cit.*, Table IV, p. 62.

[8] *Ibid.*, Table XIII, p. 308.

[9] Hader and Lindeman, *op. cit.*, Table IV, p, 18.

[10] British Association for the Advancement of Science, Popular Science Lectures, *Interim Report* of committee appointed at Newcastle meeting, 1916, p. 25.

[11] University College, University of Chicago. The subjects included in the total registrations given are astronomy, botany, chemistry, physiological chemistry, geology, zoology.

XIV

THE PUBLIC'S CHANGING INTERESTS

WHATEVER changes may have taken place in the public's interest in science, the problem cannot be treated as one of two bodies—"science" and the "public"—that approach or recede.

REASONS FOR APPARENT INDIFFERENCE TO SCIENCE

An English educator is quoted as explaining the general indifference to science by saying that "one of the causes lies in the dreary nature of the instruction in 'science' given in the secondary schools. No one who has learnt chemistry, for instance, in a day school seems to wish to learn more."[1] How widespread this effect is among those who have had the opportunity to study one or more branches of science in school we can only guess; but there can be no doubt that much potential interest and much capacity for further growth in the appreciation and understanding of science are destroyed by faulty school methods, which isolate "facts" and "principles" from their significant relationships.

Perhaps the hostility thus developed is no greater in respect to science than it is in respect to other "subjects" of instruction, but for the fact that science has come more recently into the curriculum and has not had the same time to develop a suitable methodology of instruction, and that its detailed content is not so obviously related to everyday affairs as the content of other departments. The effort to make science "objective" has often had the effect of making it lifeless. Moreover, the traditional schoolmastering, doctrinaire in its positive teachings and authoritative in its mode, is common enough in the teaching of

science to prevent the development of the experimental attitude on the part of the learner: it leaves him then, if not hostile, at least complacent as to having already "learned his stuff." Dr. S. Prentiss Baldwin of Western Reserve University writes, "There is an enormous increase of interest in wild life, and in science in every way. But, a very large proportion of adults, and young also, have closed minds, know it all, and cannot learn. The question is, How to break into such minds?"

Superintendent Willard W. Beatty of the Bronxville, New York, public schools, president of the Progressive Education Association, looks upon science in adult education as serving in part the function of a "salvage crew," calculated to retrieve values neglected or injured in the course of faulty high school or college teaching. Too much of the school work in science, he feels, is based on the assumption that "a vast amount of information has to be pumped in, without stopping to deal with the methods of arriving at principles." It is only the exceptional pupil who discovers that there is such a thing as a scientific method, from the experiments he has performed or witnessed in school. The teaching is often directed to the discovery of the potential scientist; all others are disregarded. "We owe to that vast number who did not get a very intelligent attitude from school or college some scientific background to make them intelligent 'consumers' of science. . . . This group . . . will decide whether science is worth supporting, encouraging, attending to."[2]

The school, at its best, has also operated to reduce demands on lectures. In general, the expansion of the science curriculum in the schools, the increase of vocational schools in which science found a normal and a growing place, and the rapid increase in school attendance (see pages 136 to 140) have all in considerable measure met the needs for an acquaintance with science on the part of the young people who were growing toward adulthood during the past sixty years. Just as it became increasingly superfluous to establish adult classes for teaching the art of reading, it became increasingly unnecessary to supply

classes in the elements of science. The schools, acting directly upon the population as it was growing up, not only introduced an ever larger proportion to these elements but established increasingly the custom of reading. Similarly industry and commerce have been of necessity directing the consumer as well as the worker to the wonders of science. As a result, much of what was startling or puzzling because it was novel in the nineties has now become commonplace. And people will not go to hear lectures, even "with experiments," on what they and their fellows take for granted. It is no doubt true that most people do not know or understand what has happened in science since they got their school or college certificates last year or last month; but the urge to find out is not now so keen or it can be for increasing numbers more easily satisfied—is in fact being continuously and casually satisfied through reading.

REMOTENESS OF SCIENCE

To vast numbers of men and women science appears as something altogether too remote from their interests or capacities to justify even a glance, or a hope of grasping. It is something for the "highbrows" or wizards. The achievements of science as they are forced inevitably upon our attention through the press, the radio, the other concrete applications with which we come in contact, are the achievements of an incomprehensible magic; and most of us are too humble to expect an inside view. On the other hand, where lectures are announced on the workings of some of these concrete embodiments of the modern magic, the same people will be glad to come. One observer makes a point of the importance of suitable titles for scientific lectures; people will come to hear about any topic that has been made familiar through the newspapers.

There is here suggested a deterrent due to ignorance. Not only are people ignorant as to the satisfying content or stimulation which they might presumably acquire by attending to educational opportunities but they are ignorant of the instruction and enlightenment that is available to them; they are

ignorant as to the possibilities, as to the potential meaning which the science may have for them. In many cases a suitable introduction would certainly produce the astonishing effect of disclosing to people that this is just what they have wanted: they had failed to recognize the label.

Then there are many who are probably indifferent to science on some basic ground that we may consider constitutional or temperamental: the curiosity or interest moves in other directions.

POOR INSTRUCTION FOR ADULT GROUPS

Even where there is a latent or a conscious interest in science, there are obstacles in the way of the would-be learner. Perhaps the chief of these, in the judgment of those who have looked into the matter, is the character of the instruction, whether from the point of view of the pedagogical technique or from that of the philosophical presuppositions and ideals.

As to the former, it has been found that the interest of the public can be caught and retained if the teaching begins in terms of the familiar and significant, if it appeals to the experience and concern and felt needs of the public. The instructor has to consider the background of his hearers, but he does not have to insult them or to stultify himself on the theory that their limitations leave him nothing but entertainment as a means of interesting them. The academic teacher too often discourages the students and discredits science as being of no worth.

As to the philosophical aspect, many adults are turned away from "science" because it is offered in masses of detail that are unrelated to the purposes either of those who carry on research or of those for whom science can be made to have meaning as a new way of life. In lectures and in classes, as well as in reading matter, the attempt to popularize is often restricted to an emphasis upon the wonderful achievement. "There was a time," writes Professor Dingle of the Imperial College of Science at South Kensington, "when the writer of science for the public demanded considerable mental effort from his readers, as a

tribute befitting the dignity of his subject. He showed them the steep and thorny way to heaven . . . To-day we are only too familiar with the primrose path to the everlasting bonfire."[3] We might change the figure and suggest that there is not even a primrose path, that the effort is to lift the public to the high places as with an airplane or even an inflated "ballyhoon." Former writers, continues Professor Dingle, "not only described the achievements of science; they indicated also the steps towards those achievements, appealing to reason to approve the course as well as to admiration to applaud the goal."

INADEQUATE EQUIPMENT

In many cases the chief obstacle to further educational activity in science is the inadequate accommodation and equipment for laboratory work or demonstrations. In the smaller communities the school buildings are not suitably supplied, either as to furniture or as to scientific apparatus and materials. Where high school laboratories are available, it is not always found feasible to allow the use of the equipment to adults outside regular school hours. On the other hand, there is lying idle in all parts of the country in various schools, museums, industrial plants, commercial laboratories, technical institutions, a mass of material that could well be put into the hands of interested students, or perhaps of responsible educational leaders, and made to serve effectively both to improve educational efforts under way and to make further effort more attractive to new students.

The bearing of inadequate equipment upon the interest in science among lay adults is brought out in a memorandum of the British Institute for Adult Education:

> Fifty years ago Huxley insisted that democracy was not possible unless its members understood more about science; yet during that fifty years science has become not more but less understood. Specialization has done much to drive it behind closed doors. The "amateur" scientist of the nineteenth century hardly exists now; he is either inside the laboratory or else he contents himself with reading popular books of scientific speculation.[4]

DILUTION OF LEARNING

The dilution of the contents of science instruction (or of educational lectures generally) through the attempt to make it entertaining has been justified on the ground that it will bring and hold the public, which would otherwise miss the benefits of the "education." But a person genuinely interested in learning is not going to waste his time with a superficial or irrelevant teacher, any more than he would break his heart straining at a dull teacher. Just because the adult is free to use his time for educational purposes in a way that the school pupil or undergraduate student usually is not, it becomes imperative that those who seek to beguile him with their gospel or their learning make their offerings not only sufficiently attractive but also profitable.

It has happened too frequently that a scientist who was unable to be humorous or impressive enough to hold his audience would resort to surprising little explosions or to little imitations of what magicians did in competing shows. Science lectures thus fell into disrepute among the scientists themselves; and "popular" science attained a bad name.

The conscientious dullness of the pedant and the irresponsible dazzle of the promoter equally turn serious-minded adults away from science. For science is neither the mystery to frighten away ordinary minds nor the magic to admire in the incomprehensible miracles. The divorcing of the lay adults from concern with science is illustrated by the thousands of teachers who meet certificate requirements by attaining the minimum number of credits in science and then promptly abandon the "subject." The effect of the popularization is seen in the thousands to whom their science is "made alluring by the plague of paradox" (to quote Professor Dingle again), so that the reader "not only enjoys the fun but also feels at liberty to claim science in support of whatever philosophical or religious dogmas he may hold, paradox lending itself readily to favorable interpretation by contradictory creeds."[5] This kind of science,

extensively exploited today by certain advertising technicians, is not only a source of misinformation and confusion but an effective obstacle to serious interest in science.

FASHIONS

The fact that relatively few people in any community are eagerly reaching out for more science education is in itself an obstacle to those few getting what they wish. The individual or the few who appear to their fellows queer are at a disadvantage in pursuing their own interests: when large numbers are seen with books under their arms or with butterfly nets, they do not arouse inhibiting notice. Administrators and educators who hold themselves ready to establish classes in "any subject that may be requested" are often asked for classes that they cannot supply because the enrollment is too small. In many communities in which adult education is generally acceptable, science still remains one of those things that are "not being done."

This situation is, of course, directly related to the other obstacles or sources of indifference—the way science is being taught both in the schools and to adults, and perhaps also to the unavoidable specialization and aloofness of the scientists.

> As a method of observation and reasoning, investigation and verification, . . . [science] remains the possession of a comparatively small number of specialists. It has not become the organ of everyday ways of thinking in formation of beliefs. It is not a part of the popular mind. The ways of thought of the latter remain much as they were before the rise of science. . . . [The] conclusions of science are accepted for the most part on authority and not because of personal command of the method by which the conclusions were reached. . . . Science has been limited to things remote from human life, . . . in consequence science in itself assumes a purely technical—that is, compartmentalized—aspect.[6]

SHIFTING OF CONTROVERSY

Related to the effect on the popular interest as it changes from time to time was the impact of controversy upon traditional beliefs as to theology, morals, race, human nature, which

during the last third of the past century stirred up all who were in communication with public thought. The natural sciences undermined ancient authorities by their method. They created doubts as to ancient beliefs by their speculations and findings. People might cling to their ancient beliefs and to their authorities, but they could not take part in the exciting disputes without making some attempt to find out what it was that the scientists were saying. The conservatives and the pious, intent upon preserving the old values, were challenged to attend to science; the liberals and the dissatisfied, intent upon finding more promising outlooks into the future, were allured by science as by a new gospel. While the questions raised by Darwin and his contemporaries and disciplines have not been solved, and while the concern today with these questions calls indeed for attention to science, the controversies have changed their form, some of the issues have completely disappeared for large portions of the population, and the search for more light has been for the most part delegated to the specialized investigators.

The residual concern with these issues is confronted with the more pressing problems that even before the war were shifting attention from "religion" and cosmogony to the vital issues of social and international relations. Workers' associations, which had been the chief support of science lecture courses, were turning more and more to the problems of organization, union policy, the forces that determine wages, employment, prices, and so on. This shift of interest from the natural sciences to the social sciences has, of course, been more marked during the past five years. At the same time, the confidence in science acquired by two generations of men trained in the fundamentals of modern technology has resulted in a dogmatism as to social questions that is unwarranted by the facts and out of harmony with the spirit of science. That is, while there is a legitimate turning to new problems, while more botany or chemistry seems for the moment irrelevant in the face of the pressing issues, the public concerned is too easily satisfied with fragments of "established facts" in the form of selected statistics, and with

imitations of "natural laws" in the form of economic or political generalizations and partisan doctrines.

LACK OF PUBLICITY—INACCESSIBILITY

One obstacle to wider use of existing facilities is the lack of suitable announcing or publicizing of opportunities or offerings. The schools that carry on educational work for adults are characteristically perfunctory in reaching the public. There has been a notable increase in school news in the newspapers, as well as of educational news generally; and through the efforts of the National Education Association heads of school systems throughout the country have been trained to send out material that the newspapers might print. There is a tendency toward the routinizing of announcements, and of using small type and unattractive arrangements, so that only those who are in search of the information as to courses, lectures, and so on, are likely to find or read the statements. There is apparently needed both more skilful preparation of the publicity material so that it will be more widely read, and more informative writing so that possible students will recognize that here is a matter which concerns them.

The question of accessibility of centers is of diminishing importance, since improvements in roads and in transportation are rapidly eliminating the isolated home. The isolation is likely to be related to special conditions affecting hours of work rather than to locality; and there are eventually available reading and correspondence courses.

EDUCATIONAL BACKGROUND REQUIRED

A frequent complaint against offerings in the physical sciences is the tendency to draw upon higher mathematics to an increasing extent. It is, of course, true that science must constantly seek to attain more refined and more generalized mathematical formulation; and it may be true, as Roger Bacon said, that "he who knows not mathematics cannot know any other sciences, nor, what is more, can he discover his own ignorance or find its

proper remedies." It is, nevertheless, questionable whether masses of intelligent men and women must be permanently excluded from an introduction to the problems and procedures of physics and chemistry and astronomy just because they are incapable of following the mathematical reasoning into its higher reaches and its numerous dimensions. There is a vast body of significant information and principles and an important orientation with respect to methods which are quite within the capacity of thousands who have no qualification in mathematics. The withholding of such education is unfair to the public and must in the long run prejudice the advancement of science.

The assumption that mathematics is indispensable for "real" science and the lack of suitable equipment have together forced the interest in science to content itself with lectures or verbal instruction, sometimes with lantern slides, on topics that tend to the vague and speculative. Natural history topics and marvelous tales tend to displace the physical science, and metaphysical speculation and doctrine to take the place of systematic analysis and development of problems.

There is finally to consider a variety of circumstances that oppose active participation in scientific education.

Fatigue and worry on the part of the individual already interested and already aware of opportunities would, of course, operate equally on those interested in music or literature. But with many individuals there is a divided desire because of the competing interest in art or the drama. It is no easy matter to insure a "balanced" ration of activities and reading: the temptation is always to get into a narrower groove or to trot along with companions who are more articulate or more decisive in their choices. Moreover, the public interest is constantly changing and the individual in most cases is compelled to follow the fad of the moment. Just now the interest in economics, politics, and social problems generally, is so acute that the natural sciences are relatively neglected. More important than these circumstances, however, is the energetic countereffect of the drive for recreation and, among those more favorably

situated, the esteem in which the voluntary concern with science is held.

COMPETITION WITH OTHER LEISURE-TIME PURSUITS

Not only does the ordinary individual incline spontaneously to the recreation which he actually needs, but the commercial mechanism tends to stress these counterattractions to the point of making them irresistible. "Adult education will not get well under way until the hunger for recreation is satisfied" is the declaration of Professor William F. Ogburn of the University of Chicago. Many observers attribute the decline of the scientific lecture to the competition of the movies and other forms of entertainment. That this competition is a factor has to be recognized, but without alarm and without disdain.

It will not do to say that one who is genuinely interested in science will not let himself be diverted by a vaudeville show or a ball game. Under the most favorable circumstances the voluntary attendance on lectures is to a degree a form of diversion, if not always a relaxation, rather than the discharge of a duty. For many men and women who attended scientific lectures during the late Victorian period, especially lectures illustrated with lantern slides or demonstrations, the experience was in the nature of attending a good show. Indeed, the commercialization of educational programs or of "Chautauquas" became frankly a means of purveying entertainment in great variety, including educational or cultural features. Travel lectures were interspersed with prestidigitators and musical novelties. The science lecturers were urged to be as amusing as they knew how.

In the meanwhile, however, professional entertainers and the elaborate development of the motion picture and other amusement industries have built up so strong a competition with the science lecture that the latter has suffered a serious setback. The skillful lecturer finds travel talks with motion pictures more profitable; the man of scientific temper finds the research laboratory or the university lecture room more congenial.

TECHNOLOGY VERSUS CULTURE

The social incidence of concern with science is another significant feature in the change that has taken place. The fact that "science" attained to wide popularity in this country chiefly through the technological approach has had its effect upon the esteem in which science was held by those for whom it had no immediate economic significance. It was difficult for President Eliot and his followers to find a place for science in the universities because chemistry was too little a matter of "culture" and too much a matter of increasing production and profits. In England, on the contrary, the pursuit of science was a genteel preoccupation of men who did not have to bother with accounting, and this made it sufficiently respectable to deserve attention during hours of leisure, and to make it acceptable, eventually, as one of several possible roads to culture. This contrast is related also to the distinction, which still persists in many quarters, both here and abroad, between pure science and other kinds.

With the specializations that make science the exclusive or professional preoccupation of particular men and women, and with the extension of science into the various technologies and practical arts—even the fine arts—it is possible that for a growing portion of the population science as such remains either a school subject which receives no attention at all after the textbooks are closed (except for what comes casually through incidental reading, allusion in plays, or other indirect channels) or else a remote specialty that concerns other people and that only rarely throws off something exciting or amusing. But science itself is so manifold, and there are so many activities that fall within the general pattern of "science education" or scientific pursuit, that many men and women who engage in them would not themselves identify their interests as "scientific." Natural history museums in general have found an increasing demand for their educational services; musicians and

painters manifest curiosity about the underlying nature of the processes that they manipulate; amateur photographers specialize in lighting or in the structure of emulsions or in the chemistry of developers, and some speak with much assurance and even understanding of lens systems and focal distance; nature study appeals to increasing numbers of adults; and there are even indications that lectures are of increasing popularity—where competent lecturers are available.

There is evidence that today as in the past a good lecturer will attract his audience, without regard to the subject; and also that science is in constant demand. Professor Kirtley Mather reports that among those who enrolled for classes at the Twentieth Century Adult Education Center (1933–1934) 50 per cent wanted science. For one class under the designation "Keeping Up with Science," there were ninety applicants, although the group was limited to twenty-five; and in the second semester there were over one hundred applicants. If science lecturers have suffered as against other kinds, this is probably because the available personnel does not come up to the standard; and this is substantially the conclusion of the committee of the British Association for the Advancement of Science that investigated this subject. "The demand for science teaching among adults varies at present with the supply of competent teachers. The man is more important than the subject, and the subject than elaborate or expensive equipment."[7]

[1] British Association for the Advancement of Science, Popular Science Lectures, *Interim Report* of committee appointed at Newcastle meeting, 1916, §12.

[2] Conference, April 9, 1934.

[3] Henry Dingle, "Physics and the Public Mind," *Nature*, June 2, 1934, p. 818.

[4] British Institute for Adult Education, *Educational Facilities for the Unemployed*, 1933, p. 16.

[5] *Loc. cit.*

[6] W. H. Kilpatrick and others, *The Educational Frontier*, Century, 1933, pp. 59, 60.

[7] "Science Teaching in Adult Education," *British Association Reprints*, No. 32, p. 355.

XV

FAILURE OF SCIENCE TO REACH THE PUBLIC

THE first reply to the question, "Why is science not offered more generally?" is usually that there is "too little demand." This is true enough, but only in the sense that in many cases the demand is too diffuse. "Science" is too broad and often too vague a term: the prospective students in a given area will be asking for a great variety of courses in the sciences, but not enough in any one "subject" to warrant the establishment of a class.

This of itself is a practical, chiefly economic, difficulty. To have suitable instruction the learners have to be put into groups that are more or less homogeneous as to their interests or purposes, and the ratio of instructors to learners cannot be too high. The economic limitations affect also the matter of equipment, especially if the students are to carry on any activity besides listening and looking.

INDIFFERENCE OF EDUCATORS

A reason not often given but apparent in many places, both here and abroad, is the indifference of those responsible for administration or direction. Most of the older school people in charge of educational centers have been brought up in the literary or classical tradition and are themselves insufficiently in sympathy with the demand for scientific education, or insufficiently appreciative of the educational possibilities of science, from what may be called a "humanistic" point of view. This applies both to making provisions for science and to publicizing the opportunities for those who might be interested. They may

not systematically disparage science, but they neglect to urge it where it might be of value.

LACK OF TEACHERS

Fundamentally the demand for education in science, as in other special fields, depends upon its attractiveness. The supply of excellent teachers would seem to be a limiting factor. This, too, is in part an economic problem, since better teachers are to be had at a price. But only in part; for apparently an increasing proportion of those who become sufficiently interested in the pursuit of science to master a particular branch prefer a career in some academic form of teaching or in research or in a combination of the two. Adult education, which at one time seemed sufficiently important and dignified to command the attention and services of a Tyndall or a Haeckel, and which still has the personal support of a few of the leading scientists in every country, has come to be identified with more or less formal elementary or secondary instruction for men and women who missed the opportunity during the earlier years—to get the instruction suitable for the earlier years. Or else it has to do with "popularization" that too often is only a rather crude vulgarization.

In these circumstances attention needs to be directed to the men and women who are both adequately trained in scientific fundamentals and outlooks and personally competent to instruct and stimulate and guide adults in the study of science. And there are such. One finds in the universities and colleges men who are skillful in teaching, and who like teaching, but who are never encouraged to advance themselves except through "research" that can be measured in terms of papers published. The young instructors especially would find most helpful for clarifying their own thinking an effort to make clear to other adults what their problems and difficulties are, and what their plans are for the solution of the problems. But they are made to feel that it is more important to stick to the laboratory than to waste their time with relatively "ignorant" laymen.

LOW ESTEEM OF POPULARIZATION

The abuses which have become so flagrant in the irresponsible "popularization" of science, through lectures, through print, over the radio, have also antagonized serious scientists and educators and have in many cases led to the conviction that the "public" is too stupid to understand "science," and that those who attempt to "popularize" are mountebanks, with whom no self-respecting scholar would wish to be identified.

MEETING THE PUBLIC'S SUSPICIONS

In the recent past, especially since the increase of unemployment with the economic crisis, many scientists have become aware that there is a dangerous and probably growing undercurrent of resentment against the "scientists" because the latter have been so extensively touted as the source of the great technological gains which culminated in the crash. Furthermore, the hostility toward science is not confined to ignorant workers who have lost their jobs through the perfection of labor-saving machinery. Among trained and intelligent men and women, even among professional scientists, there is to be found a perplexing confusion between admiration for the human wit which solves problems and magnifies power, and resentment against the irresponsibility which permits this power to fall into hands that use it for the destruction of the home and of the higher human values.[1] There has appeared a corresponding disposition among scientists to search for some means of counteracting this tendency, or of going still further in "selling" science to the public. It is realized that science cannot thrive in an atmosphere of ignorance and superstition and hostility; and it is only through science that these obstacles can be overcome. It is accordingly easier at the moment to get scientists to attend to the "public." The need, however, is not to sell more science to the public but to get the public, so far as possible, to assimilate the scientist's mode of seeing and thinking. To this

end the scientist would have to identify himself more earnestly with the common concerns of the public, instead of emphasizing those capacities and functions that differentiate him from his fellows.

INDIFFERENCE OF SCIENTISTS

Perhaps the most serious obstacle to the effective diffusion of the scientist's point of view is a certain indifference, not to say disdain, on the part of large numbers of scientists, as to what the public does want. This is to a degree an outcome of the objectivity and detachment which science has itself cultivated. Evangelism has lost its prestige. While there has been a tremendous increase in systematic propaganda of all sorts, and while the individual evangelists, in whatever field, can still catch the public's attention, the furthering of science as a new gospel, which was relatively common during the latter half of the past century, has steadily declined. Scientists as a group have attained a degree of security; they have come to take themselves for granted. They do not so much feel the need of inculcating in the public an "appreciation" of science, nor have they, until quite recently, felt so much the hostility to science that was apparent in an earlier generation. Indeed, science has come to be so largely under the protecting wing of government and of industry that scientists in large numbers identify the advancement of science as well as their personal welfare with the established order and the vested interests, and they have in this way acquired a certain contempt for the rabble that does not speak their language or share their ideals.

This cleavage between the specialist and the lay public shows itself in the outspoken attitudes of certain scientists and educators:

> If anybody wants to know what science is about, or what it is trying to do, there is nothing to stop him. Everything of importance is to be found in books and reports and monographs and the scientific magazines. The meetings of scientific societies are open to anybody who cares to come. If one cannot understand what is printed in our

reports, or what is discussed at our meetings, then science is none of his business, however curious he may be. Eighty or ninety per cent of the population could not understand science no matter how hard we tried to teach them, and it would be a waste of time to try. We are happier and more useful in our laboratories than we would be in the classroom, or on the lecture platform, or trying to rewrite our ideas so that everybody can read us.

It must be said here that the attitude expressed in the foregoing paraphrase from various sources is not shared by most of the scientists and educators interviewed. The vast majority feels that it would be desirable to have a wider appreciation and understanding of science in the public at large, without, however, being clear as to how effective educational work to this end can be furthered. And many were equally outspoken both as to the need and as to the urgency.

The condescension with which the scientist looks upon the multitudes justifies itself on the ground that the masses are obviously his inferiors intellectually. But scientists of all people should recognize that the cultivation of special talents and capacities is made possible only through a division of labor in which the gains of specialization are duly distributed through mutually advantageous exchange. Moreover, scientists should recognize that the further growth of science, to which they presumably attach importance, depends upon a reorientation of all social elements—including the scientists themselves.

THE IRRESPONSIBILITY OF SCIENCE

The men and women who embody the dynamic processes and the products which make up science can remain indifferent to political and economic issues only if they are satisfied to see science subordinated to a partisan or sectarian group, as in Germany or Russia at the moment. Such subordination perverts science by prescribing both the kinds of research it may carry on and the kinds of solutions which it may find. Such subordination leads also to a systematic rejection of scientific discoveries and processes because these happen to emanate from sources that are offensive to the controlling caste or sect.

The indifference of the scientist as to what happens to his science or to the rest of the world is in fact not altogether sincere; but it is at any rate very shortsighted. Already we can see it bringing about such absurd outcomes as the arbitrary elimination from the physician's armamentarium of devices and procedures derived from "enemy" sources. If we accepted the same philosophy we should refuse to apply the "germ theory" in case we happened to be displeased with France. We should avoid visiting the planetarium or using diphtheria antitoxin if we happened to dislike the Germans, as the Germans are today officially shutting their eyes to syphilis because the Wassermann test and the arsenical treatment were developed by Jews; and anti-Catholics would breed their plants and animals without making use of Mendel's aid. We cannot, of course, blame the scientists of Germany for the ridiculous and tragic outcomes of the political dictatorship in that country; but we may well consider that unless the scientists in this country cooperate wholeheartedly we cannot hope to cultivate among the general public a point of view which would make similar consequences unlikely in the future.

The scientist is presumably concerned enough with science itself to wish to continue with his own work. The systematic disregard of the public and of the public's problems means a passive and complacent acceptance of the customary conditions, an unquestioning drift with the tide, in the expectation that the powers that be will protect the interests of the scientists at least until well past the deluge.

There are, however, indications of a positive need for more direct concern by scientists with the affairs of the general public. The science which has made possible the present world has also made impossible a continuance of certain features of that world side by side with science: that is, there is a growing disharmony between the spirit of science and the spirit of those features of modern life. We have been repeatedly warned that in the elaboration of modern scientific technology man has built up a monster that may yet destroy him; but in its contributions to

the modern industrial world science has helped to create a monster that will surely destroy *it*. Already the scientist can see his cherished dream of abundance through the application of his principles to conservation and production dissipated through the systematic sabotage inherent in the manipulation of prices for profit. He sees his ideals of rational dealings on cause-effect principles flouted through the exaltation of ignorance and superstition into the gods of trade. Discoveries and inventions which he had hoped to see applied for the advancement of human welfare he sees instead destroyed or locked away because they threaten certain private interests. He sees his humane sentiments of tolerance, openmindedness, and universal exchange of ideas and services ruthlessly overridden by narrow bigotries and provincialisms that thrive by cultivating suspicions, hatreds, and mutual fears among races and nations.

The indifference of the scientist to what is happening in civic and political and economic areas of life is in effect a refusal to accept responsibility with respect to the society that makes science possible and meaningful. It is true that in this regard the scientist does not differ from other specialists, for the tendency in all specialization is to focus responsibility upon competence and expertness. The result, however, is to make of the scientists a body of retainers who ask no questions as to the social consequences of their activities, who are content to enjoy opportunities for congenial work and the concomitant emoluments and privileges, and who are prepared to exercise their talents, when called upon, in support of those who hire them, and again without regard to the social implications of the uses to which their efforts are put.

The present-day conditions and trends thus challenge science to concern itself with the mind of the public. While this challenge is in no sense a reproach (since historically the status and the attitudes of the scientist could have been no other than those we find them to be), it must not be ignored by the leaders and trainers of scientists, if we are to retain the social and

cultural values which science has already yielded and which it is presumably capable of expanding and extending indefinitely. We must conclude that for the sake of science itself as well as of the civilization which science has transformed, science must be made a part of the public mind.

[1] Christian Gauss, *A Primer for Tomorrow*, Scribner, 1934, "The Threat of Science."

XVI

SUMMARY OF FINDINGS AND RECOMMENDATIONS

THE generalizations, suggestions, and recommendations enumerated in the following summary have not all appeared explicitly in the foregoing discussion; they all seem, however, to be adequately supported by the material assembled in the course of the study.

Among those who have given some thought to the place of science in adult education there is a tendency

1 To value increasingly the hobby interest, or the personal curiosity motive, as against technical or vocational interest, and as against formal or academic interest; that is, the pursuit of science furnishes a legitimate and worthy mode of using one's free time and resources;

2 To lay more emphasis upon interpretative as against purely informational efforts, with special reference to the implications of science for independent thinking and for social changes and adjustments;

3 To require more activity or participation on the part of the "learners," as against purely verbal instruction, or telling and showing on the part of the teachers, and against purely passive acceptance on that of the learners;

4 To attach increasing importance to cultural outlooks and to the development of appreciations, as through integration with psychology, philosophy, and the historical and social studies.

GENERAL CONCLUSIONS

These general conclusions summarize the substantial agreements reached by sub-committees appointed at a conference

of thirty distinguished leaders in education, science, and public thought, on April 9, 1934:

1 There is need for wider diffusion of scientific knowledge, scientific appreciations, and scientific attitudes among all classes of the population, as contributing to (*a*) the direct advancement of the individual's interests and concerns; (*b*) the advancement of common or cultural interests; and (*c*) the promotion of civic interests and social integrations.

2 Adult education in science must include, in addition to the expansion for the individual of his own horizons and the spreading of information on findings and theories of science, a cultivation of appreciations of the problems which preoccupy the scientists and of the methods which they employ; a familiarization with the techniques of inquiry which are distinctive of modern life; opportunities for the free pursuit of personal curiosities and interests in scientific fields; the interpretation of scientific findings and theories; and a clarifying of the implications of both the methods and the results of scientific pursuits.

The need is not so much to sell science to the public, or to convince the public that science is important or valuable, as it is to help people assimilate whatever benefits scientific attitudes and practices may yield, through the acceptance and use of science in daily thinking. The assimilation of science by the general public, it is assumed, must have important bearings upon the cultural outlook, as in the repudiation of magic and mysticism in the common life, and as leading to a more widespread concern with the social implications of science.

3 For the adults who wish to continue thinking with the assistance of specialists, opportunities in the field of science are generally inadequate; there seems to be special lack of opportunity for continuity of inquiry by individual men and women equipped to carry on more or less individualized study and research with a minimum of instructional or tutorial guidance.

4 Methods have to be adapted to different interests and purposes and personal equipment: not only do men and women

in adult groups differ from one another in the sense recognized by educators working with school or college groups, and not only do they come with divergent purposes to a given class or course, but they bring to any educational undertaking a body of experiences and reflections that distinguish their mental activities and emotional reactions from those of immature students, and it is necessary to differentiate methods of instruction and direction and guidance from those employed in schools and colleges.

5 It is desirable to make the fullest use that is practicable of our resources in materials, in equipment, and in personnel.

6 The furthering of adult education in science must be free of all doctrinaire bias, and from domination by any sectarian, partisan, or economic interest.

RECOMMENDATIONS

A In general, schools, colleges, university extension departments, and all other agencies and institutions engaged in educational work in science for adults should

1. Make use so far as possible of existing natural groups;
2. Adapt their offerings to the special requirements of the groups and individuals that they seek to serve, according to their interests and needs and varying degrees of preparation;
3. Adapt their methods to the purposes, experiences, and capacities of those whom they address, in disregard, where necessary, of academic criteria;
4. Make their resources available to individuals, so far as possible, as well as to organized groups or classes;
5. Plan educational operations so as to stimulate contemplation or reflection and to encourage further reading and other activities;
6. Direct learners or participants to books, museums, and other sources of relevant information, interpretation, etc.;
7. Make use of all suitable means of publicity for informing all who may be concerned with the opportunities and

facilities they offer and establish means through which individuals interested can make known their wants;

8 Search for and encourage especially talented workers to further the particular types of educational work in which they are engaged;

9 Make full use of special occasions to arouse public interest in scientific processes, achievements, activities;

10 Cooperate with other agencies in arrangement of programs, publicity, coordination of functions, use of equipment, exchange of counsel.

B Museums and similar institutions should

1 Make special efforts to design their standing and special exhibits for maximum educational results;

2 Encourage the formation of voluntary groups to make use of their facilities;

3 Arrange lectures, demonstrations, conferences, study groups for continuous educational work, as well as for special occasions;

4 Make their collections more generally accessible for study by interested individuals and groups;

5 Extend the availability of their materials through branches, loan collections, and exchange of exhibits with other institutions;

6 Make more extensive organized use of outdoor resources, trailsides, etc.;

7 Correlate exhibits, labels, loan collections, guide leaflets with available books to direct visitors and readers to sources of further information, interpretation, and other help.

C Academies of science and similar organizations should

1 Open their meetings to the lay public and invite on occasion special groups or organizations to their meetings;

2 Arrange special meetings, conferences, lectures, exhibits, and demonstrations for the general public;

3 Encourage the formation of amateur science and naturalists groups;

4 Give systematic consideration to the educational needs of the public which they can serve, as well as to the educational needs of their members;

5 Cooperate with other educational agencies.

D Research institutions and research units of other organizations should

1 Arrange special lectures, exhibits, demonstrations based on their investigations but designed for the enlightenment of the lay public on various levels;

2 Arrange to make their publications effectively translated for wider use;

3 Arrange to have their exhibits and demonstrations accessible over wider areas, through travel or through duplications;

4 Cooperate with scientific and educational groups on special occasions, such as conventions, toward making facilities more widely accessible.

NEEDS

The survey of the general situation with respect to science in adult education points to the existence of certain needs and leaves several questions open.

Initiative

Who is to take the initiative in doing what is often obviously needed? Practically every institution and every organization finds its personnel fully occupied: nobody seems to be waiting about for lack of something to do, nobody wants to take on more responsibility. The first suggestion must be in terms of what is already being done. Publicity is part of the routine of various schools and other institutions; more publicity is called for, or a shift in emphasis. Programs have to be expanded or redirected. Cooperation among agencies must be systematized or strengthened.

No general formula can be offered for organizing groups of men and women who might be interested in science, or for

lining up the resources that may be available; we may expect, however, that in any given community the most vital agency in the educational field will take the initiative. In some cases it may be a professional society or a leader in some industry that will undertake to make available the services of competent scientists or other teachers. In other cases the Adult Education Council or some individual in the school system will attempt to bring together leaders and learners. The initiative will vary according to the imagination, the energy, and the enthusiasm of the various individuals composing the intellectual community.

Publicity

Interest has to be aroused for wider concern among scientists, educators, administrators, and others, as well as among the lay public, with the place of science in modern life.

Existing facilities have to be made more widely known. Better publicity is needed for exhibits, lectures, important books. Especially is there need for the publicizing of opportunities for individuals and groups in a way that avoids pressure and yet makes apparent what there is of value to those concerned.

It is through publicity also that support has to be mustered to encourage the educators and scientists, as well as the men and women who are to be enlisted in educational activity; for all must be made to feel that engaging in such activities is worthy and proper, not to be disparaged as the preoccupation of cranks or passed by as a fad.

While the newspapers and other agencies for publicizing are ready to cooperate, and while prominent citizens can be got to endorse almost any worthy cause, there is need for more than the ordinary variety of publicity or promotion. The approval of community leaders who have attained some degree of prestige may be valuable, but it must be used cautiously and with discretion. It is necessary to guard against the danger of getting perfectly respectable people to make themselves ridiculous by uttering solemn pronouncements on matters which they do

not understand any better than the man in the street, and the further danger, perhaps more serious, of arousing the suspicion that such unanimity among the respectable people might indicate an attempt to "put something over" on the masses. At least, such things have happened before.

Cooperation and Coordination

The educational agencies in a community, and eventually those of a larger area, need to cooperate in various ways in order to make the most of their necessarily limited resources.

The pooling of facilities to serve a central office of information, as in a school or library, could make easier the distribution of public intelligence as to opportunities, as to the distribution of various facilities, as to the availability of expert counsel, and so on. A central office for the emission of publicity material to the newspapers would make for uniformity and often for economy and increased effectiveness; sometimes for the avoidance of conflicts in arranging for special lectures, exhibitions, excursions, and the like. And where new channels of publicity can be developed, as through commercial establishments, commercial exhibits, various bulletin boards, a central office would save contacts and sometimes annoyances.

Such cooperation would extend to enlisting the friendly interest of scientists and other specialists, and again without multiplying the demands upon these unduly. It would make possible the establishment of a panel of available teachers, lecturers, consultants, writers, and others who can take part in the broader educational program.

The cooperating agencies, including public or governmental divisions concerned with education as well as private or endowed institutions, could plan their several programs to avoid wasteful duplications, or to make the optimum use of their facilities. They could find opportunities, perhaps trivial at first, for dividing up functions and costs. For example, the library or the adult education council might be best situated for handling all the publicity; lectures requiring a lantern might all be held

in one center, and those requiring demonstrations in another. The task of preparing text material, guide leaflets, instructional outlines, can be divided among the special teachers in several institutions, instead of expecting each school to do everything. The more economical use of equipment and arrangement of hours for the educational use of the commercial motion picture theater are also made possible through such coordination of efforts.

The systematic canvassing of the community to find what educational interests are not being satisfied can best be managed by a central office, and it is seldom that any one agency has the means to conduct a complete canvass alone.

Finally such cooperation must lead to the discovery of needs on the part of individuals or of groups which can be served by existing resources, if an effort is made to redistribute the actual use being made of the facilities. And similarly the joint efforts will point out ways of extending resources for use in new ways.

The initiation of cooperation may be expected to lead automatically to the improvement of efforts through the exchange of counsel and experience. It would lend dignity to the efforts of the several agencies, relieved of the need to press for patronage in a competitive field, and it would at the same time raise their standing in public esteem, facilitating the enlistment of needed support.

Stimulation and Encouragement

Among the general problems that lie beyond the resources locally available, or beyond educational functions under purely local control, are several that have to do with "promotion," or stimulation from outside.

Newspapers. In the case of newspapers, for example, it seems desirable to bring editors and journalists to a systematic consideration of socially more useful ways of treating science as news, and of supplementing such use with suitable background and interpretive material. Perhaps some committee or other agency could take this matter up with the schools of

journalism or with the professional associations or with selected individual editors. Some of the newspapers that are already doing excellent work in the handling of science might be induced to go further in developing for their readers the suggestions of science news as to possible implications, differences of interpretation, changes from traditional theories, possible effects, and so on.

Editorials in Magazines. Although the special scientific and technical magazines are read by men and women who are already interested in science, and who are presumably capable of doing their own interpreting and criticizing, it would seem desirable to encourage the printing of interpretive and philosophical articles and editorials in some of these periodicals, as is done in the English weekly *Nature.*

Government Intelligence. There seems to be a serious gap in the publication of important releases from various government bureaus, dealing with scientific findings and applications that bear directly upon the interests of the public, but making no urgent demand upon the editor as "news" or as excitingly written "features." Indeed, such items often appear to the editor as indistinguishable from "propaganda" and are promptly discarded. There is involved here not only the question of getting such educational material prepared more attractively and effectively for the information and enlightenment of the readers, but also that of getting for such material special recognition as calling even for complete rewriting rather than categorical elimination along with irresponsible clamorings submitted on the same kind of paper.

Books. Special stimulation appears to be needed for the production of suitable books for the general reader, in special fields of science. Competent writers might be found to cooperate with scientists in the working out of such books. It is not possible always to find the competent writer; but there is the more general difficulty that, whereas such a writer is ready to acknowledge that he does not understand science, the scientist is not so ready to admit that he cannot write.

There is need also for stimulating the production of simple books that can be cheaply produced in large quantities and cheaply distributed. It is worth while to consider further the possibility of getting cheap reprints of scientific books that have already had a distribution to a relatively small public in the trade editions.

Readers' Guides. There are needed outlines and guides for the individual reader. In some cases the authors of suitable books can be induced to prepare such outlines, and the publishers to distribute them. In other cases an experienced teacher is better able to prepare the study guide, and distribution can best be effected through a non-commercial agency or through sales at a moderate price.

Lectures. It is felt that exceptionally able lecturers in science should be encouraged to give more time and effort to the careful preparation of finished addresses that they might present to many sets of auditors, in different parts of the country. Some of these lectures might be frankly planned for the purpose of arousing interest in the possibilities of scientific studies and pursuits for the individual.

Schools. There is the need for enlisting the cooperation of scientists and others in the development of educational programs so as to integrate science as outlook and as method with the other subjects of instruction, as distinguished from finding in the program a fair proportion of time for science as a separate subject of instruction. This would lead further to cooperating with those carrying on research in education so as to bring about the adoption of scientific attitudes and methods as accepted ends in the general educational objectives. It would be desirable also for representatives of scientific and educational groups to cooperate in the development of teacher-training programs that would put more emphasis upon community needs as manifested in the lives of adults, and upon including the philosophy of science in their educational procedure.

Colleges. In many educational institutions of collegiate and university rank there is need for inaugurating short courses

primarily to establish more vital contacts between the scientists and the public.

Research

As in the case of the enumerated needs that call for special promotion, there are various problems that lie beyond the resources and responsibilities of a particular community or institution, and that are yet of importance to many institutions and communities concerned with the advancement and improvement of science education among adults.

There is need for a broad, systematic study of the various methods in use and of their relative effectiveness for different purposes or for different groups. It would probably prove profitable to carry on experimentally developments and demonstrations of new methods, and of ways of improving prevailing practices.

Costs. Studies should be made of the costs of different types of adult education in science, according to subjects, methods, levels of preparation and accomplishment, objectives, varying auspices, and so on.

The Press. There is need for a study of the variations among newspapers as to the amount of space they devote to science items, and as to the basis for selection. It would also be desirable to make a comparative study of newspaper science in this country and in other countries, as to amounts, as to quality, as to character of selection, and perhaps as to other aspects.

A similar study of scientific and natural history magazines would probably indicate needs and opportunities for consolidation and for absorption in the interests of more effective use of material as well as in the interests of economy. There are no doubt some magazines that need most of all to be completely suspended, as there are others that should be helped to find adequate support or wider distribution.

Correspondence Courses. The limitations of correspondence courses are generally recognized among educators; but they have been found very useful in certain areas. A study of their

further improvement, with special reference to the diffusion of science, should be helpful.

Academic Procedures. There is needed a serious investigation into the advantages and disadvantages, for the various aims in adult education in science, of credits, competitive rating, academic standards, and syllabuses. It has been felt that in many institutions the university extension divisions have not reached as fully as they might the adult public, especially the labor groups, and that, on the other hand, they have not maintained the academic prestige to the extent that had been expected. It is undoubtedly desirable to make wider use of university resources in equipment and personnel, but it may be necessary to develop administrative forms and educational procedures that will command the confidence and support of the specialists as well as of the lay public.

Radio—Cinema—Television. There is need to extend systematically the experimental development of the radio (accompanied by suitably illustrated text or syllabus), of motion pictures, and of sound pictures for popular education in science. There are many one-reel films that are interesting and impressive, and potentially valuable as arousing interest and directing attention to various scientific concepts and problems; some of these could probably be interpolated in commercial theaters if their use involved no additional cost or risk to the theater owners. It would probably be worth while to experiment with a number of such films in various areas and arrange to canvass the reactions of the auditors.

Experimental theaters devoted to scientific films would be worth trying out on the basis of the success which has accompanied the Planetarium. It would be assumed that there are people who are sufficiently interested to see such films—to take the time and to pay a fee. In several large cities there are today unused theaters that could be used at comparatively little cost; and the producers of films could be induced to cooperate in an extensive and controlled tryout.

Scientific societies should be especially alert to the development of new methods for diffusing scientific ideas and understandings through such technical devices as the radio, the cinema, and television.

Drama. It is suggested finally that it would be desirable to explore the possibilities of the drama as a medium of adult education in science, employing for the purpose skilled dramatists, actors, directors, and other specialists to prepare stage and film dramatizations of selected scientific developments and episodes.

CONTINUITY AND ECONOMY OF EFFORT

In its report to the Leicester meeting of the British Association for the Advancement of Science in September, 1933, the association's Committee on Science Teaching in Adult Education says:

> The problem of stimulating the demand for science studies [among adults] is a matter for those who realize the importance of the subject to the community generally and understand the serious danger to social stability that accompanies ignorance of the facts of science, or of scientific method. It is for those to suggest means of awakening interest in these studies and put them in operation.[1]

Those who most immediately "realize the importance of the subject" may very well be those who are themselves engaged in scientific research or in science teaching or in both. Yet it is desirable to separate any promotional work from the concern of those who are actually teaching, since the latter must be protected from appearing to urge their services upon the public or the community. Moreover, there is much more needed than the stimulation of interest.

In order to insure continuity of effort and to make the most effective use of existing facilities and organizations, it would be desirable to establish some sort of joint committee, or a special agency, to stimulate and coordinate needed promotion and publicizing as well as special research and other functions designed to advance science in adult education.

A joint committee would naturally have representatives of the American Association for the Advancement of Science, of the National Academy of Sciences, the National Education Association, the American Association for Adult Education, Science Service, the American Sociological Society, and perhaps also the National Research Council, the Social Science Research Council, and some other organizations and institutions.

Such a body, whether an independent agency or a joint committee, should be in a position to call upon officers or other representatives of various organizations and institutions, including public or governmental offices and agencies, regularly or occasionally, for counsel and for cooperation, in general or for special projects. And it should be equipped and implemented for advancing the common ideals of those who realize the importance of the subject in its broadest social bearings.

[1] British Association for the Advancement of Science, *Science Teaching in Adult Education*, 1933, p. 348.

APPENDIX

ORGANIZATIONS AND AGENCIES FOR ADULT EDUCATION IN SCIENCE

NEARLY every adult is a member of one or of several groups that are virtually homogeneous for certain purposes. The inquiry into any special phase of adult education at once raises two questions: First, what groups or organizations are particularly amenable to the suggestion that they utilize existing facilities for extending an understanding and an appreciation of science among their constituents? The other question is: What institutions and other resources are available for furthering science education?

Secondary questions then arise as to initiative, as to more precise definition of objectives, and as to ways and means.

It is probably fair to assume that practically all adults above a certain level of intelligence are potential learners. The experience of many museums points to the feasibility of interesting a variety of lay groups in one or another phase of "science" which may be very remote from the concerns that first bring the members of the group together. The so-called "service" or luncheon clubs, many kinds of women's organizations, fraternal societies, trade unions, granges, neighborhood improvement societies, fishing clubs, garden clubs, in addition to the many nature study clubs, can all be brought to sample the offerings of science.

INITIATIVE

The initiative for introducing such groups or their individual members to the opportunities for interesting and profitable study must be taken by those who are prepared to offer a

service that is in essence free. That is, there must be no undue pressure or "sales" effort, and the adults who are invited to share an educational opportunity must be considered free to take or to leave, without prejudice. Very often, indeed, some member of such a group can be found to do everything necessary to arouse the interest of his associates and to organize a group for study. In the case of trade or industrial groups it is questionable whether it is ever wise to have promotion of educational programs come through the management, although in many cases the support of the management is legitimate and desirable.

Leaving to the adults utmost freedom in taking or leaving educational opportunities does not imply a passive attitude on the part of educators, scientists, leaders in institutional development, or administrators. Publicity of various kinds is not only legitimate but absolutely essential. Even tax-supported institutions have the obligation of informing the public as to what they are doing, what they have in their programs that may interest one or another of the many who constitute the public and who in the end support the institution. As with the public schools, there is need for the development of a type of public information that is free from the blandishments and pressures of competitive advertising, and yet equally effective in catching the attention and transmitting the message.

AGENCIES

The following list indicates the large number of agencies concerned with furthering science in adult education.

I Educational institutions and organizations
- Public school systems; high schools
- University extension divisions
- Urban universities; summer schools
- Institutes and academies
- Independent schools and study groups
- Correspondence schools
- Museums
- Educational divisions of government bureaus (for example, agricultural extension; health boards; national park service; geological and natural history surveys, etc.)

- Voluntary educational (propaganda) organizations (for example, tuberculosis, public health, child welfare, social hygiene societies; cancer committees; etc.)
- Libraries

II Scientific organizations and agencies
- National associations (American Association for the Advancement of Science; National Academy of Science; National Research Council; American Philosophical Society; etc.)
- State and local academies of science
- Special scientific societies
- Professional academies and societies—medical, engineering, chemical, electrical, etc.
- Research institutions
- Specialists; lecturers; writers

III Organizing agencies (in addition to the types in I and II)
- Adult education councils
- Professional groups
- Alumni associations; American Association of University Women
- Trade and industrial groups
- Voluntary social and recreational groups and clubs; directors of conventions, conferences, exhibits, etc.
- Social settlements and welfare centers

IV Publicizing agencies
- Newspapers
- Bulletins and pamphlets
- Books
- Library; posters, etc.
- Radio
- Movies

INITIATIVE, COORDINATION, AND RESEARCH

Almost any institution may exercise initiative in extending its own program; and in any given community or category such an agency may also call upon others for cooperation and, with others, plan a coordination of efforts for the best utilization of available facilities. Some institutions may also be in a position to carry forward investigations into special problems in the field of science education among adults. Generally speaking, however, there is need for extraneous stimulation to overcome inertia, for disinterested suggestions as to coordination, and for independent initiation of research—functions that very few operative agencies can set in motion or continue.

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